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THE AMERICAN GAS LIGHT JOURNAL

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[OFFICIAL NOTICE.]

Committee on Nomination of Officers, American Gas Light Association.

OFFICE OF THE SECRETARY, PROVIDENCE, R. I., May 25, 1894.

I hereby give official notice that, at a meeting of the Council of this Association, held at Cleveland, O., May 15, 1894, there were appointed (as per the appended list) members of the Committee to Nominate Officers for the Association for the year beginning October 19, 1894, said Committee to report to the Association on October 17, 1894, at Washington, D. C.:

F. H. Shelton (Chairman), Philadelphia, Pa.; M. S. Greenough, Cleveland, O.; D. H. Geggie, Quebec, Canada; F. S. Richardson, North Adams, Mass.; G. T. Thompson, St. Louis, Mo.

Respectfully, A. B. SLATER, JR., Secretary.

[OFFICIAL NOTICE.]

Committee of Arrangements, American Gas Light Association.

OFFICE OF THE SECRETARY, PROVIDENCE, R. I., May 25, 1894.

I hereby give official notice that at a meeting of the Council of this Association, held at Cleveland, O., May 15, 1894, there were appointed (as per the appended list) members of the Committee on Arrangments for the 22d annual meeting of this Association, to be held at Washington, D. C., beginning on October 17, 1894:

C. B. Bailey (Chairman), Washington, D. C.; J. S. McIlhenny, Washington, D. C.; Wm. Henry White, New York City; John McIlhenny, Philadelphia, Pa.; T. J. Hayward, Baltimore, Md.; C. H. Dickey, Baltimore, Md.; Frederic Egner, Norfolk, Va.; A. B. Slater, Jr., Providence, R. I. Respectfully, A. B. SLATER, JR., Secretary.

BRIEFLY TOLD.

A VERY ODD CONCESSION.—Politics and "pull" have been manifestly prominent in the management of the gas supply of Albany, N.Y., since the original gas properties of that city were absorbed by the syndicate, who, some years ago, by fair means and other means, succeeded in frightening the then possessors to the point of selling their rights. Prior to the advent of the Bradys, the McElroys, the Flowers and their co-partners on the field of Albany's gas supply, some sort of fair ruling held sway in respect of gas prices; for, although the Whitneys, the Pumpellys, the Pruyns, and those whom they represented in the days of, say, 12 years ago, could not be claimed to favor cheap gas, neither can it be said that they made fish of one or flesh of another, when it came to charging so much per 1,000 cubic feet. The rates which the last named established were uniform, wherefore it was a case of making a selection without a wide range in which to make one's choosing. The new owners, however, outgame the old, in that they are bold enough to say that the man who uses gas for heating a soldering iron, for warming a tailor's goose, for operating a gas engine—in a word, for using gas commercially, for purposes other than lighting—shall pay for such use more than the or who uses gas for "cooking and domestic

heating." Possibly we are wrong in this conclusion, but unadvised, as we are, over the real meaning of an official notification recently published by the Municipal Gas Company, of Albany, we submit that no other belief can result from a reading of its lines. Here it is:

"Municipal Gas Company: From June 1st, 1894, the price of gas for cooking and domestic heating, where connected with separate meters, will be $1.25 per thousand feet."

Such is the notice the Municipal Company, of Albany, is now paying for in the advertising columns of the local papers, and we ask if, in the absence of other information than that contained in the advertisement, a different conclusion respecting its meaning can be reached than the one at which we have arrived? Mr. Walton Clark, in a paper read before the American Association (at the New York meeting, 1891), on the topic of whether it was a question of equity or policy to charge meter rents, remarked that the "idea of a meter rent has been that it represents what the Creoles" (and no one will contend that Creoles are other than odd chances in nature) "call a 'lagniappe'—something demanded in addition to the regular and legitimate payment for service," and to carry the thought just a trifle further, it would seem that the Municipal Company's managers have got to the point where even a Creole would be stumped to coin an expression which would pithily point the Municipal Company's practice. In short, if the users of gas for "domestic cooking and heating" in Albany are entitled to gas at $1.25 per 1,000, the tailor and his goose and the tinker and his iron ought to have a share in the benefits.

William Anderson is Surprised.—"P., of L.," writing to the Journal, under date of the 19th inst., says: "A party of the Guild of Gas Managers and their friends, to the number of about 25, preceded by an elegant roll top desk and chair, of antique oak, and followed by caterer Weber's best turnout, invaded the house of Mr. William Anderson, of the East Boston Gas Light Company, on the night of June 15th. By a curious coincidence Mr. Anderson had been called away late that afternoon, to advise in the matter of some new work about to be erected in a neighboring town, and so found it difficult to return home before evening. He was only apprised of the invasion, on entering his door, by the sudden turning out of the lights, which were not extinguished quick enough to prevent him from seeing a hat tree loaded to its branches with hats three deep, and the sound of one of those plaintive ditties for which the Kineo Club is so famous. The combination struck him dumb, and when President Wood, in behalf of those present, presented him with the desk, 20 per cent. of CO would not have knocked him out more effectively. He was, however, brought to all right, and gave the party a hearty welcome. A most enjoyable evening was spent, during which Mrs. Barrows treated the party to a nicely finished series of cornet solos, and Mr. Barrows also favored them with songs and excellent work on the violin. Grandpa performed one of those stately minuets, so much in vogue in old 'colonial times,' with much spirit, to the combined accompaniment of piano and violin, while the versatile talent of the Guild fairly outdid itself. Duets, trios and solos by the Glee Club, violin solos by the virtuoso, classical music by the choirmaster, stories by the raconteur, high tragedy and low comedy by the artists in that line, and a sumptuous lunch before the break up, led to a separation with all hoping that 'William' would always be able to sign big checks on that desk, and have them honored by the banks as he was honored by his friends."

The Equitable Gas Company, of this city, was a sufferer last week through an explosion of vapors in one of its drains that communicated with its naphtha storage tanks. The total loss is less than $5,000, and the damage would likely have been much greater were it not for the prompt appearance of the Company's Engineer (Mr. Enfer) on the scene, who personally directed the movements of the Company's fire force.

Graham's Construction and Working of Regenerator Furnaces.—We are in receipt of a copy of Mr. Maurice Graham's clever work entitled the "Construction and Working of Regenerator Furnaces," which is published by Messrs. Spon & Chamberlain, of this city. The author's purpose was to collate a series of practical hints on the construction and working of regenerator furnaces, in the shape of an explanatory elementary treatise on the system of gaseous firing applicable to horizontal and inclined settings in gas works; and we can truthfully say that his purpose has been most successfully carried out. Although the volume is a small one, the subject has been carefully covered, and in a style so commonsense that he who reads the book cannot fail to comprehend its teachings. It is profusely illustrated, and the publishers are to be congratulated on the handsome way in which they have done their part of the work. The price of the volume is $1.25.

Motors for Lighting or Generator Gas vs. Engines with Saturated or Superheated Steam.

[A paper read by Mr. Bryan Donkin before the Incorporated Institution of Gas Engineers.]

Having been invited to read a paper before this meeting, the author considered that a comparison of gas motors and steam engines might not be without interest to the Institution, the members of which are occupied in making lighting gas now so much used for power.

The capital account of gas undertakings in the United Kingdom is about 60,000,000 sterling, and about 10,000,000 of tons of coal are yearly carbonized. Mr. G. C. Trewby estimates that in London there are 70,000 cooking and heating stoves, and 2,500 gas engines. During the last few years gas motors have greatly increased in size and power, and their manufacture has become an important industry, both here and on the Continent. They are better made, and their range of power is very considerable, varying from ¼-horse power up to 600 indicated horse power. Both in size and power, they seem to be progressive. With lighting gas, the sizes mostly in demand are 1 to 10-horse power. The "factor of public satisfaction" is certainly on the increase for small gas motors.

In all larger gas works, motive power is continually required, day and night; and arrangements are made to produce it in duplicate in case of any difficulties or accident. Energy or power is chiefly used in these works for driving exhausters, water, tar and liquor pumps, and coke breaking machines. Gas engines are, and have been, used for driving exhausters in small gas works; but they cannot be said to be popular with gas engineers. The author knows of some cases where they have been removed after a fair trial of some years, and replaced by steam engines. One inconvenience is that, unlike steam engines, they must be started with the work off, generally by means of live and dead pulleys. When the engine is running, a clutch is used to connect the motor shaft with the load. With lighting gas, there is generally little gain, in point of economy, per horse power, in using the larger sized gas engines instead of steam engines. A good deal, however, depends upon the size of the engine, price of gas, type of steam engine proposed and local cost of fuel.

In comparing the working cost of gas with steam, the author considers that any general data are of little use. The cost and heating value of the gas must be given, whether lighting or generator, and the type, size, horse power and make of gas motor. Lighting gas is much dearer than generator gas when used for power. With steam engines, the type of engine should be specified, the steam pressure, whether condensing or non-condensing, the speed, whether steam jacketed or not, and the cost of fuel. The cost of gas per 1,000 cubic feet, and of fuel per ton, will vary in each locality. Lighting gas is very much used in hundreds of towns and villages, and for small powers it is very convenient. It is only necessary to turn on the gas and water, and the engine can be started in a few minutes. With a small steam engine, a boiler and chimney are necessary; and their application is sometimes difficult in many small workshops and rooms. Getting up steam also takes time.

For larger powers, generator gas only can be employed with advantage in competition with good steam engines. The gas generator is equivalent to the steam boiler, and the heat contained in the coal is, in both cases, transformed into motion or energy through the medium of steam and gas respectively. Such motors have replaced fairly good steam engines in mills, with economical results. Generator gas is specially made in a small separate apparatus, and cannot be used for illuminating purposes. When mixed with air in a gas engine cylinder, it gives the maximum explosive power. Gas, unlike steam, can be stored in a holder.

The quantity of lighting gas used in tests or trials in internal combustion motors should not only be given in cubic feet per indicated or brake horse power, but the heating value in thermal units per cubic foot should be added, as the gas varies a good deal in thermal value in different towns and cities in England and on the Continent. A little instrument is now sold on the Continent, for giving the number of thermal units in any gas, and it seems to yield reliable results. The gas is burnt, so many pounds of water are heated so many degrees, and the heating value is thus determined per cubic foot. The Berthelot-Mahler calorimeter can also be used for determining the heating power of any lighting or other gas. With town gas, the lighting and heating value are in a certain proportion, and have been plotted on a curve.

When town or generator gas comes in contact with pipes or cylinder walls of different temperature, little or no influence is produced on it. The case, however, is different with saturated steam. Until they are hot, the pipes condense the steam; and even when hot and well covered, there is always some condensation due to radiation, and some re-

duction in pressure. In the cylinder of a steam engine there is considerable condensation, as the walls are generally much colder than the steam coming in contact with them, and few engineers give thought to raising their temperature to somewhat near that of the steam by steam jackets, to reduce condensation. Their object is generally to get the cheapest steam engine: but, as far as steam, fuel and boiler are concerned, they obtain the dearest. If more power is required, the cry is for more boilers, instead of endeavoring to economize the present steam consumption by making tests and trials on existing engines to ascertain the real facts.

With superheated instead of saturated steam, the case is very different, as, before any condensation takes place and water is formed, it must part with all its superheat. This is the great reason why superheated steam is so economical in steam engines; it also increases largely the volume of the steam. If steam already exists in any mill or factory, and is necessary for other purposes than power, there is generally little advantage in using gas motors for economic power in lieu of a good steam engine.

A comparison of the initial temperature in the cylinder of a non condensing steam engine and that in a gas engine is not without interest. With saturated steam at a pressure of 60 pounds, the temperature is 293° F., and at 100 pounds, 338° F. Most gas engines now work at (say) from 2,500° to 3,000° F., so that the temperature is very much greater with gas; and yet there is no practical difficulty with lubrication.

The cast iron cylinder walls, in both gas and steam engines, play an important part. In the former, owing to the relatively high temperatures, it is necessary to cool them continually by circulating water, although by this arrangement about 35 per cent. of all the heat received is lost. In steam engines, the best types are provided with a jacket of steam, with the object of keeping the walls nearly as hot as the initial steam inside, and thus considerably diminishing condensation. The results of steam jacketing have been published in the last few years by a number of experiments made by the Research Committee of the Institution of Mechanical Engineers. The economy effected by properly applied steam jackets, with sufficiently large steam and water pipes to and from the jackets, is from 10 to 20 per cent. This saving depends much on the type of steam engine, the percentage of surface jacketed, and whether the engine is single cylinder, compound, or triple, condensing or non-condensing. It is most necessary to jacket the larger cylinder of a compound engine—not only the barrel but the covers, the latter being the most important surfaces.

Lubrication is effected without difficulty in steam or gas motors; perhaps the latter require rather larger quantities of mineral oil. Gas engines certainly need more attention than steam engines. This is the opinion of those who have both motors at work in the same mills. Steam engines work nearly always double acting, or with two impulses per revolution (with the exception of those going at high speeds). With internal combustion motors, Beau de Rochas' 4-cycle is chiefly used, giving an impulse every two revolutions; and they are nearly always single acting With steam, therefore, there are four times as many impulses as with gas.

Flywheels must be heavier with gas than with steam engines, and two are often used. These tend to decrease the mechanical efficiency. Governing is generally done in gas engines by cutting out explosions; but with both these types of motor, there is now no difficulty in running very regularly—say, within 3 to 4 per cent. of the normal—and both are suitable for driving dynamos, and are largely used for small electric lighting plants. At all the larger electric stations steam only is used. There is no great difference in the piston speed in feet per minute, or in the number of reciprocations per minute, in these two classes of motors giving the same power.

Where combustion is imperfect, the discharge of the products from gas engines tends to vitiate the air near; but, on the other hand, there is no smoke, as with a steam boiler. Starting is much more easily done with steam engines, and with the work on. Gas motors must be started empty; and this involves a small additional cost and risk of breakage. Accidents to the different parts of gas engines are rather more frequent than with steam motors, but there is less risk of fire than with a boiler.

The comparative first costs are as follows: A 5-brake horse power gas engine, running about 200 revolutions for town gas, costs about £80; a steam engine, single cylinder, non-condensing, non jacketed, running about 240 revolutions, with vertical boiler, 80 pounds pressure, costs £80 also; a 25-brake horse power gas engine, running about 170 revolutions with gas generator, about £400; a steam engine of the same power, 120 revolutions, compound, non-jacketed, condensing, with Cornish boiler, 100 pounds pressure, about £360; a 40-brake gas engine, running at 160 revolutions, with gas generator, £570; a steam engine for the same power, compound, condensing, steam jacketed, at 100 revolutions, and Cornish boiler, 100 pounds, £470; a 75-brake horse power gas engine, with two cylinders, running at 160 revolutions, with generator plant, £950; for the same power, a steam engine, compound, condensing, steam jacketed, 95 revolutions, with Lancashire boiler, 100 pounds, £670. Generator gas should be used where economy is an object—say, for engines above 12-horse power.

The mechanical efficiency of the two motors is the percentage of the brake on the indicated horse power. In well made steam engines it is from 85 to 90 per cent.—in other words, from 10 to 15 per cent. of the total indicated horse power is required for driving the engine itself. In well made gas engines, experiments have shown that the mechanical efficiency is from 80 to 85 per cent. In steam and gas engines, the thermal efficiency, or the percentage of heat converted into work to the total heat received, varies much with different engines, according to speeds, sizes, loads, pressures and temperatures used. In good steam engines at full load, it is from 10 to 14 per cent., depending on steam pressures, speed, etc. With good gas engines, at full load, it varies from 18 to 23 per cent. It should be stated, in experiments and making comparisons, whether these are made with full or half load. Gas engines work with less economy at light loads than steam motors. In the case of gas engines driven by town gas, there is no solid residuum, as with steam boilers and gas generators, thus avoiding the small cost of carting away ashes and clinkers.

In comparing gas with steam, if the work is likely to be intermittent, and the motor frequently stopped and started, as is very often the case with small motors, gas is found much more convenient than steam. For working continuously, night and day, all the year round, steam is, however, more reliable, particularly in applications where any stoppage, even for a few minutes, would have serious consequences. In gas works, where steam engines are nearly always used, better types should be selected, and steam jackets used to economize steam and fuel. Steam pipes should be more carefully covered, and the engines more often tested and indicated.

By superheating, the temperature of the steam is raised without affecting its pressure; and this is generally carried out by placing superheaters in the boiler flues, or utilizing the waste heat at the end of the boiler. There is considerable economy in using superheated instead of saturated steam. Such steam is now largely used on the Continent, without any practical difficulties, in some 100 to 200 engines, developing 10,000 to 15,000 horse power. It is employed in all kinds and types of steam engines—single cylinder, compound and triple, jacketed and non-jacketed, condensing and non-condensing. In the proceedings of the Institution of Civil Engineers, and various Continental societies, there are accounts of many trials of superheated *versus* saturated steam. The gain in economy, according to these experiments, depends upon a variety of circumstances, the type of engine and boiler used, and now they are worked. It varies from 10 to 25 per cent. when the superheaters are placed in the boiler flues.

The author has made many experiments with different types of superheating apparatus, and one quite lately at Hamburg; and he has always found very considerable economy due to its use. This steam is found to raise the temperature of cylinder walls, and it parts with its heat without causing condensation. The degree of superheat varies from 30° to 100° F.—that is, the steam is heated to this extent above the temperature corresponding to the pressure. Thus, with 50 lbs. of saturated steam having a temperature of 298° F., if superheated 100° the temperature will be equal to 398° F. With 100 lbs. of saturated steam, having a temperature of 338° F., if 100° superheated the temperature will be equal to 438° F. There is, however, considerable prejudice against its use; but with proper mineral oil and ordinary care the slide valves and pistons give no trouble, if the superheating is kept within moderate limits. Moreover, the temperatures used are always very much lower than in gas engines. Professor Kennedy has made a trial on a small Serpollet boiler, generating steam with 200° F. of superheat. With a small non condensing engine 5 in. by 5 in., running at 285 revolutions per minute, the result was 25½ lbs. of steam per indicated horse power per hour with 55 lbs. pressure. This is only about half the steam consumption of an ordinary steam engine of this size. The engine piston and valves were in good order after a long time. In another test on a small non-condensing engine with 5 inch cylinders, and running at 284 revolutions, using superheated steam, the steam per brake horse power was only 30 lbs. This experiment has lately been made by Mr. Sequin, in Paris, with 4 atmospheres steam pressure.

For the purpose of comparison it will be well to divide gas engines into five categories:

1 to 10 B H.P.—Smallest size, suitable for town gas. Consumption about 21 to 23 cubic feet per I.H.P. of London gas at full power on trial.

10 to 50 B.H.P.—Medium size, for either town or generator gas, according to the price of town gas and fuel. Consumption about 20 to 22 cubic feet per I.H.P. of London gas at full power on trial.

50 to 100 B.H.P.—Large size, for generator gas. Consuming 1 to 1¼ lbs. of good fuel per I.H.P. per hour on trials at full power.

100 to 500 B.H.P.—Largest yet made, for generator gas. Using about 1 lb. of good fuel per hour on trials at full power.

500 to 1,000 B.H.P.—Not yet made.

Steam engines are made in all these sizes, and much larger. By far the greatest number of gas engines are made of the smallest size, from 1 to 10 indicated horse power, and using town gas. For medium size, also, large numbers are sold; but for 50 to 100 horse power engines there is a much smaller sale. The above quantities of gas and fuel are about what would be consumed on trials with a full constant load, not with intermittent work. London gas may be taken as yielding about 615 to 635 thermal units per cubic foot; and generator or Dowson gas about 160 thermal units per cubic foot. From these figures, and knowing the cost of gas per 1,000 feet, or the cost of fuel and probable load, the approximate cost, working by day or week, can be calculated for a given town.

The figures contained in the following table have been taken from Prof. Witz's report, and they have been rearranged and put into the present form by the author. But he cannot altogether agree with these figures, as, with a more economical steam engine of the best type, only 1¼ lbs. of best coal per brake horse power would be sufficient at a moderate speed and steam pressure. With this latter consumption the cost

Comparison of the Working Costs per Day for a Gas and a Steam Engine with about 75 Brake Horse Power.

Particulars.	Steam Engine and Boiler to Compare. (Not Actual Trial.)	"Simplex" Gas Engine and Gas Generator Test by Prof. Witz.
Heat agent	Welsh coal, 4 per cent. ashes.	Coke, 6 per cent. ash; anthracite coal, 5½ per cent. ash.
Heating value	15,700 T.U. per lb.	
Generator, etc.	Lancashire boiler, 650 sq. ft. heating surface.	Gas generator.
Pressure	5 atmospheres = 75 lbs.	Pressure of explosion, about 120 lbs. per square inch.
Medium	8½ lbs. steam per lb. coal.	Gas = 83.7 cu. ft. per brake horse power.
Thermal efficiencies	72 per cent. boiler.	70½ per ct. generator.
Cylinder	Steam, single cylinder.	Explosion and combustion of gas, single cylinder.
Action	Double acting.	Single acting.
Impulse	4 impulses per 2 revolutions.	1 impulse per 2 revolutions.
Diameter	15½ inches.	22½ inches.
Stroke	3 ft. 3 in.	3 ft. 1½ in.
Revolutions per min	66	101.
Piston speed	435 feet per minute.	630 feet per minute.
Kind of jacket	Steam jacketed walls, heated.	Water jacketed walls, cooled.
Piston	Ordinary piston.	Plunger piston.
Initial temperature	70 lbs. = 316° F.	2,200° F., about.
Engine thermal efficiency, or percentage of heat turned into power to total heat received.	9¼ per cent.	18 per cent.
Thermal efficiencies	7 per cent. boiler and engine.	12.7 per cent. generator and engine.
Mech. effic. of motor.	75 per cent.	69 per cent.
To drive engine itself.	25 per cent.	31 per cent.
	100	100
Water	Condensing and feed.	For jacket water, say one-fifth that required for a steam engine.
Oil for lubrication	Rather more required for gas engine.	
Lbs. coal per B.H.P.	2.6 lbs.	1.34 lbs.
B.H.P.	75.	76.
Space occupied	360 sq. ft. engine, including boiler and chimney.	470 sq. ft. engine, including gas generator.
First cost fixed	£1,290 for engine, boiler and chimney, pipes and foundations.	£1,290 for engine, pipes, gas generator, etc.
Cost of building	About the same in each case.	

Cost per Day of 10 Hours for the Foregoing Steam and Gas Engine. (As given by Prof. Witz.)

Steam.				*Gas.*			
Depreciation, repairs, and interest	£0	13	6	Depreciation, repairs and interest	£0	13	6
Welsh coal, 2.6 lbs. per B.H.P. for 10 hours, at 23s. per ton	1	0	0	1.34 lbs. per B.H.P.	0	12	0
Oil and grease	0	1	3	Oil and grease	0	2	0
Driver	0	5	0	Driver	0	5	0
				Battery, etc.	0	0	4
Total	£1	19	9	Total	£1	12	10

Or a difference for 10 hours' work of 6s. 11d. per day in favor of gas, or, say, £100 a year, taking 300 days. This is the calculated saving for these particular motors, exclusive of getting up steam or gas, and during gas trials at constant full load.

per day with steam and gas would be about the same. But then it may be said that the best large modern gas engines, with generator gas, would only require about 1 lb. to 1¼ lbs. of good fuel; so that the above proportion would not probably be altered materially. Much will depend on the price of fuel in the particular town under consideration.

Mr. Dowson has done much, and was the first to make and introduce cheap generator gas, and to bring its advantages well before the public. He has written several excellent papers comparing steam and gas engines. A few extracts from trials, etc., from his last paper at the Institution of Civil Engineers are here given.

According to Mr. Dowson, gas engines for electric lighting, developing about 7,000 horse power, have been sold in England, and "Otto" engines for 11,000 horse power in Germany. Doubtless the majority of these work with town gas. Messrs. Crossley say the number of "Otto" gas engines in use in England is now about 20,000, and we may assume perhaps nearly double this number for all kinds of gas engines. To give the best economy, a gas engine should be worked at full load. There are no high power gas engines for electric supply stations yet working in England or in large cities on the Continent; all the existing central stations using steam. In London, mostly, quickly running compound and triple Willans engines are employed; but there are also other types, chiefly non condensing. Mr. Dowson advocates the use of gas motors and generator gas instead of steam for central electric stations.

A Dowson gas generator usually consists of a small steam boiler giving superheated steam, a generator, a cooler, a sawdust scrubber, and a holder. The gas passes through water twice, and finally through the coke and sawdust. For an 80 brake horse power plant, the cost erected is about £325; for 530 horse power, about £1,100.

At "Chateau Say," with 650 glow lamps, an "Otto" engine, with Dowson gas, consumed 1.2 lbs. of fuel per indicated horse power hour.

At the Chelsea Flour Mill, a 60 nominal horse power twin cylinder gas motor, with Dowson gas, 17 inches diameter and 2 feet stroke, going at 156 revolutions, and giving 118 indicated horse power, has been about two years at work. The amount of anthracite and coke used during a constant full load test was about 0.87 lb. per indicated horse power per hour. The governing is said to be satisfactory, and the cost of wages and lubrication is about the same as with a steam engine. The gas consumption is 63 feet per indicated horse power per hour.

At the Severn Tweed Mills, New Town, there are four gas engines, with Dowson gas developing about 200 horse power. Total fuel per brake horse power per hour 1¼ lbs. of anthracite—six days' test. Cost per brake horse power = 0.13d. With coke from gas works, only 1¼ lbs. per brake horse power were used. The cost per brake horse power was the same as with anthracite, as the coke was cheaper.

At the Godalming Paper Mills there are several gas engines, giving some 400 indicated horse power. Generator gas is used; and the average consumption of fuel is given at 1 lb. per indicated horse power per hour. Messrs. Spicer consider that gas engines require more attention than steam engines, and they have had some breakdowns with them.

At a weaving mill at Halifax there are four gas engines of about 200 indicated horse power, using generator gas from gas coke. The consumption is about 1.4 lbs. per indicated horse power per hour.

At the Uxbridge Water Works, a water pumping test was made in February, 1892, using generator gas. Consumption, 1 lb. of coal per indicated horse power, or 1¼ lbs. per horse power of water lifted per hour. Approximate power, 16¾ indicated horse power. The Surveyor of these water works has recently reported on the cost of the present gas engine, as against the former old steam engines. With *steam*, working 14 hours per day, it was £555 per year; with *gas* (? town gas), working 17 hours, £374 per year. The type of steam engine is not given.

A 25 horse power double acting Griffin gas engine, tested by Messrs. Dick, Kerr & Co., gave from 82¼ to 83½ per cent. of mechanical effi-

ciency. With Messrs. Crossley's 30 horse power nominal "Otto" gas engines the mechanical efficiency was 86 per cent.

The best fuel for generating Dowson gas is anthracite, as it yields no tar. If anthracite is too dear, gas coke can be used. Comparing Dowson gas and 16 candle power lighting gas, their relative explosive force is about 3.8 : 1; so that about four times the volume of the former is necessary to give the same power as with average town gas. There is a large proportion of nitrogen in this gas; and it is easy to see how great must be the excess of nitrogen, as soon as the gas is diluted with air and ready for explosion. Sir W. Siemens mentions—and it has been confirmed by others—that, when town gas is used for driving gas engines for an electric generating station, the consumption of gas is about 50 per cent. less than the volume of gas required to give the same amount of light in ordinary burners.

The following is taken from the recent and very interesting Howard Lectures of Professor W. C. Unwin, F.R.S., at the Society of Arts, on the "Development and Transmission of Power:" Many of the disadvantages of solid fuel are diminished by employing coal to produce gas, and using it in internal furnaces or gas engines. Gas motors work with a higher thermal efficiency than steam engines. The cost of ordinary lighting gas is increased, both by the need of a large generating plant to meet the great fluctuations in the demand for lighting and heating, and by the large distributing charge involved in supplying a great number of small consumers. If gas were made especially for heating and power purposes, either coal, water, or producer gas could probably be distributed to power users at less than half the present price of coal gas. From test trials made on a large pumping engine of the London Hydraulic Power Company, the consumption was 2.2 lbs. of coal per indicated horse power hour; but in ordinary intermittent work it is one-third more. This includes keeping the boilers hot, getting up steam, stoppages and starting of the engine, and with very different loads by day and by night.

The whole of Messrs. Crossley's large works are driven by gas engines and Dowson gas from anthracite coal. There are eight gas motors of from 12 to 30 nominal horse power, indicating collectively about 325 horse power. In reply to the author's inquiries, the firm state that the consumption per indicated horse power hour is from 1 to 1¼ lbs. The net cost to them of the anthracite fuel, labor, interest on capital and repairs, works out at about 2½d. per 1,000 cubic feet. Comparing this with average town gas, and allowing for thermal value per cubic foot, the equivalent cost would be about 10d. per 1,000 cubic feet. About 2,000 engines were made at these works last year.

A single cylinder gas motor, indicating 280 horse power, driving a large flour mill in France, was lately seen by the author working with generator gas from French coal. The preliminary trials gave about ¾ lb. per indicated horse power per hour. This is taking the coal over about two weeks, with continuous work night and day with full load. This engine will give a maximum of 320 indicated horse power. The maximum pressure of explosions in the cylinder is about 200 lbs. per square inch.

Professor Kennedy says that, at half load, the consumption with gas or steam engines per brake horse power hour is about 40 per cent. more than at full load. It was mainly here that the loss in the engine due to "load factor" comes in. A steam boiler does its best at half to three quarter power, and at quarter power it works very wastefully. When a boiler is only kept hot, but not supplying steam, it may be called the "stand-by" loss. The Professor adds that, from his experiments with boilers, by shutting down the stop valve, he reduced this loss to 10 per cent., or the consumption of fuel in a boiler not making steam was about 10 per cent. of the whole consumption. In case of fog, in electric stations or in large gas works, it is often necessary to keep up steam, so as to be ready for an engine start at any moment. Professor Kennedy uses in the electric supply stations under his charge non condensing engines, giving on test trials 24 lbs. of steam per electric horse power = 32 lbs. of steam per unit. His boilers give 11 lbs. of steam per pound of good coal, and 9½ lbs. reach the engine during a test. This works out to 3.4 lbs. of coal per electric unit delivered on a test. Instead of this, the actual figures for three to four weeks gave 5.3 lbs. This important difference between a test trial and several weeks run is due to all losses at the station, keeping boilers and pipes under steam, and engines running at different loads, etc. As to a saving, by improving the engine load factor, a gas engine would not, he considers, help at all. Such an engine has exactly the same drawbacks as a steam engine in this respect, and more information is needed as to losses in a gas generator over several weeks, corresponding with the losses in the steam boilers mentioned.

The author has lately made some experiments with Mr. C. C. Carpenter on a compound horizontal condensing steam engine at the Vauxhall works of the South Metropolitan Gas Company, using saturated steam. Six trials were made—three with, and three without, steam in the jackets. The results of these experiments gave from 12 to 16 per cent. gain due to the jackets in use. With 60 lbs. pressure in the boiler, and with all the jackets in use, 19½ lbs. of steam per indicated horse power hour were consumed. The Cornish boiler used gave an evaporation of 8 to 10 lbs. of dry broken coke from a temperature of feed water of 212° F. Dry coke per indicated horse power hour, 2.5 lbs.: coke per brake horse power hour, 2.7 lbs. Taking the price of coke at 13d. per cwt., this will give 0.3d. per brake horse power per hour. The indicated horse power varied from 43 to 63 in different tests, but the load was kept fairly constant during each eight hours' run. The thermal efficiency of the engine, with 60 lbs. steam and all jackets on, was 12¼ per cent. The boiler efficiency varied from 63 to 79 per cent. according to the method of stoking. The boiler was not forced. The calorimetric value of 1 lb. of gas coke varied from 12 to 13 lbs. from 212° F. per cent.; ash and clinker in coke, 9 to 14 per cent. The priming of the boiler was under 0.5 per cent., or practically *nil*.

Mr. Holgate gives the following figures as to the first cost of steam and gas motors for an electric plant of 1,160 indicated horse power for 10,000 incandescent lamps; area available, 880 square yards. Steam—Five 160 horse power boilers, six steam engines, six dynamos, ropes, etc., £18,365. Gas—Dowson generator plant, eleven gas engines, eleven dynamos, belts, etc., £16,500.

Mr. Denny Lane has advocated the distribution of power gas for gas engines by mains in the usual way, as being a much cheaper method of distribution than with wires for electricity, pipes for water or air, or other methods. He says that a 6 inch gas main costs about £550 per mile, and at 4 inches pressure would deliver 9,000 cubic feet of gas one mile, and would yield about 350-horse power, and at a higher pressure much more. A 6-inch, more expensive, water main, under the usual pressure of 950 lbs. per square inch, will only carry about 116 horse power. The cost also per horse power by this hydraulic system is very much greater than with gas. Mr. Lane considers that good heating and power gas can be produced on the works for 1s. 6d. per 1,000 cubic feet with a profit.

It may be of interest to add the description of a method of working in use for the last ten years, in which lighting gas is supplied for a certain number of hours during the 24, and cooking and power gas for the remainder. At the Winterthur gas works, in Switzerland, the two kinds of gas are supplied through the same set of town mains, but from different gasholders. Illuminating gas is supplied during the few dark hours of the day, and power gas for the remaining or much longer time. In this way the mains of the town are utilized, and earn interest during the longer portion of the 24 hours, when power, heating and cooking gas only is required. Some two or three hours before dusk each day the gas is enriched by using cannel coal. After midnight the use of this coal is suspended, and power gas is distributed from another holder, the larger holder being shut off. The number of hours per day and night these two kinds of gases are available to the consumers varies, of course, with the season. The cooking and power gas is much in demand; but some little inconvenience is felt by the consumers during the change from the power to lighting gas, and until the mains have become filled with illuminating gas. In large cities or towns this inconvenience would be fatal; but for smaller industrial towns and villages, where cooking stoves or gas engines are, or in the future may be, much used, it might probably be supplied, by permission of the authorities, with advantage to all. When this duplex system was started the consumption of heating and power gas was about 10 per cent. of the total; but now it is about 50 per cent., and is still on the increase. There are some 46 gas motors at work and 800 cooking stoves. The population of this town is about 19,000. The charge for lighting gas is 5s. 7d., and for non-lighting gas, 3s. 4d. per 1,000 cubic feet—a very considerable reduction; and at the same time it is much better suited for cooking, heating and power. The owners of these gas works have paid better dividends during this double gas supply, and have also been able to reduce the prices. They now belong to the community of the town of Winterthur.

There are about 29 towns in Switzerland (or more than half the gas works in the country) which are selling power and lighting gas on a similar system, and using the same mains for both. Coal costs in Switzerland about 26s. 5d. per ton, and cannel coal about twice as much. To carry out this system there are two gas meters in every house, but one service pipe from the street main serves for both. The outlet pipes from the meters are connected with different rooms, as may be desired, for lighting or cooking and motive power. Sometimes a single meter is used with a clock attached, which automatically turns off or on at a certain time one or the other quality of gas. In other cases, automatic arrangements of a different character are used. In Switzerland there are from 600 to 700 gas engines in 37 different towns, with a total of some

2,000 horse power, mostly for small motors. About one-tenth of the gas at present made at Winterthur is used in the streets—something like half for private illumination, and the rest for power and cooking.

The author has referred to many descriptions and trials given in *Engineer* and *Engineering*, and also to various papers and proceedings of English and Continental institutions and societies; and he finds that the most economical steam engines (exclusive of high speed motors, some of which are very economical) are those of the Sulzer type, made by Messrs. Sulzer and Messrs. Carels. They are thoroughly steam jacketed, and are used for mills and for driving dynamos, in sizes from 50 to 500 horse power and larger. Many tests have been made on these engines by independent experts, and by French, German and Belgian engineers. For details of these, the author's letter to *Engineering* of Jan. 15, 1892, may be referred to.

In single cylinder condensing engines using 70 to 80 lbs. pressure, the consumption varies from 18¾ to 19¾ lbs. of saturated steam per horse power hour. Taking a good boiler and good coal, giving 10 lbs. of steam per pound of coal—a rate of evaporation which has often been realized, and even exceeded in good practice—the coal consumption would be 1¾ to 2 lbs. per indicated horse power hour.

With compound condensing engines and pressures of 80 to 100 lbs., the consumption was 14 to 16 lbs. of saturated steam per indicated horse power hour, and taking 10 lbs. of steam per pound of coal, as before, this gives 1½ lbs. of coal per indicated horse power hour.

With triple condensing engines working with steam pressures from 100 to 150 lbs., the consumption was from 12 to 13 lbs. of saturated steam per indicated horse power hour, giving, under the same conditions, 1¼ lbs. per indicated horse power hour. The above figures include the jacket water. If superheated steam were used, these figures would be still further reduced, so that in trials with the best number of expansions in triple engines and constant load, we may expect soon to attain a consumption of 1 to 1¼ lbs. of the best coal per indicated horse power hour. It is assumed that the engines and boilers are properly worked and not forced.

In conclusion, the author has endeavored to make a fair comparison between gas and steam motors, and has quoted the most reliable modern trials he has been able to find for both classes. In choosing between these two motors for a given load and set of conditions, the considerations mentioned should be carefully taken into account. The first cost must naturally be considered, although the cost of daily working is much more important; next the price of fuel and gas in any given locality, and then the risk, convenience, noise, vibration, horse power, etc. There is no doubt that considerable economy is still to be realized both in gas and steam engines. The best oil engines, like gas motors, have a great future before them, there being no boiler and no gas generator. They are now competing closely with gas, and they may eventually prove to be the most economical and convenient internal combustion motors without boilers for many purposes.

The Strength and Resilience of Structural Cast Iron.

[A paper by Prof. J. B. Johnson, of St. Louis, Mo., before the Foundrymen's Association.]

The working qualities of structural castings are of extreme importance, so much so that the necessity for these qualities goes without saying. Furthermore, these qualities can be tested, and are tested, of necessity in the finishing of the castings for service. Any failure of the working qualities is immediately discovered by the machinist and corrected by the foundryman. The strength and the toughness of the castings, however, are two qualities which are not usually determined at all except by such incidental indications of strength and toughness as come from the breakage of these parts in practice under loads or shocks, which they were assumed to be able to resist. This indication is, of course, a very inadequate one and gives at best no measurable test of the strength or toughness of the iron.

In this paper the author will undertake to show the necessity for these qualities and how they may be determined by actual tests. He will further try to show that strength and toughness are not identical, and that the one does not give any indication of what the other may be. Thus a very strong iron may be a very brittle one, and on the other hand a very tough iron may be comparatively weak.

The Strength of Cast Iron.—Cast iron is not usually used in structures to carry tensile stress alone, but generally used for columns and beams. In machinery castings, however, where all the parts are made of cast iron, some parts are subjected wholly to tensile stress. There are three kinds of strength, therefore, of cast iron, which may be determined by actual tests—namely, tensile strength, compressive strength, and strength in cross bending, as a beam. When a cast iron beam, or any cast iron form, is broken in cross bending the fracture always occurs on the tension side of the member, and hence the failure is one in tension. In the case of cast iron columns, provided the load is symmetrical and the column is equally strong on all sides, the failure would be one in compression. It so happens, however, that the tensile strength of cast iron is a good measure of both its cross bending and of its crushing strength—that is to say, that cast iron which is strongest in tension is likely to be strongest in compression and in cross bending.

All kinds of strength of cast iron, therefore, may be determined by a tension test. It may also be determined by a cross bending test. The tension test has one advantage over the cross bending test, inasmuch as the whole length of the tension test specimen is subjected to the same stress, and if there be a flaw anywhere in the entire length of the specimen, failure will occur at that point, and hence the weakness of the specimen will be shown wherever this weakness may occur. In cross bending tests, where the bar is loaded in the middle, the tendency to break is greatest at the center, where the load is placed, and if a flaw occurs near one end it would not be discovered by the bar rupturing at that point. Hence we may say that the tension test is a better test to discover any possible flaws which may be in the specimen, but the cross bending test is probably better for determining the strength of the metal, since, in the latter case, the rupture must occur near the center of the beam, and if this portion of the beam be free from flaw the true strength of the metal is determined. It is also much easier to make a test of cast iron in cross bending than in direct tension, and furthermore a cross bending test furnishes the means of determining the toughness of the iron, as will be explained later, and therefore in what follows cross bending tests will be taken as a standard method of determining both the strength and the toughness of the iron.

Cross Bending Tests.—The most convenient form for a test specimen of cast iron for cross bending is a rectangular cross section about 24 inches long. The size of the cross section should have some relation to the thicknesss of the webs or parts in the structural forms into which the metal is run and for the strength of which the tests are made. Thus, if the iron is to be used in forms where the thickness of the metal is about 1 inch, the test specimen should be made about 1 inch square. If, however, the metal is to be used in parts the thickness of which is not more than ½ inch, then it would be well to make the test specimens ½ inch thick and perhaps 1½ to 2 inches wide.

In the case of stove iron the test specimens should not be more than ½ inch thick and about 2 inches wide. The length of the specimen is immaterial, and should be such a length as is adapted to the testing machine or apparatus. The cross section of the test specimen should, of course, be uniform from end to end—that is to say, it is of the same size throughout.

The same care should be taken in the molding and casting of test specimens as would be taken in any regular casting where sound and perfect work is desired. It would usually be cast horizontally, but with due precautions, as in the interception of the slag, in the escape of the air, in the smoothness of the sides and the perfection of the corners. It should be so molded as to free itself readily from the sand, and should be tested without planing down.

In testing such a bar it should be supported on knife edges near the ends, these knife edges being at a definite distance apart. The distance between these knife edges being the length of the beam, so far as the test is concerned, any overhanging ends of the specimen beyond the bearings having no effect on the strength of the beam. This specimen is then broken by placing a load at the center, preferably by means of another knife edge, and this load applied slowly and uniformly and without shock. About the only way to do this properly is by means of a screw turned steadily and very slowly. There are various cross bending testing machines on the market, the principal ones being manufactured in Philadelphia. The modulus of rupture of cast iron in cross breaking corresponds to the tensile strength of the iron, and if the iron were perfectly elastic up to the point of rupture this modulus of rupture would be the same as the tensile strength in pounds per square inch, but since cast iron takes some permanent set before it breaks, the theoretical formula no longer applies, so that the computed modulus of rupture as determined from cross breaking tests is found to be always very much larger than the true tensile strength of the cast iron, its average value being from 1½ to twice as much as the strength per square inch in tension. If the cast iron has a tensile strength of 2,000 pounds to the square inch, its modulus of rupture in cross bending will be, therefore, from 30,000 to 40,000 pounds. It is common to assume that a tensile strength of 20,000 pounds corresponds to a cross breaking strength, or

modulus of rupture, of about 36,000 pounds per square inch. To find this modulus of rupture from a cross breaking test on a rectangular bar we use the following simple formula :

$$f = \frac{3}{2}\left(\frac{Wl}{bh^2}\right)$$

where f = modulus of rupture in cross bending in pounds per square inch ; W = load at center of beam in pounds ; l = length of beam between bearings in inches ; b = horizontal breadth of beam in inches ; h = vertical height or depth of beam in inches.

It is much better to use this formula and compute f from the cross breaking weight W, and the dimensions of the bar b, h and l, than to use some thumb rule, as, for instance, that a bar 1 inch square and 12 inches long should carry a load of 2,000 pounds at the center. This would give a modulus in cross breaking of 36,000 pounds, which indicates a very fair quality of cast iron, so far as strength is concerned, but if the specimen should prove to be a little more than 1 inch square, or a little less, there is nothing in the specification to show by how much the loads should vary to compensate for this change of size. Whereas, if it be specified that the modulus of rupture should be 36,000 pounds, that could be determined from the above formula very easily whatever the dimensions may have been. In fact, b and h should always be measured to the nearest $\frac{1}{1000}$ inch, and, of course, the castings could not be made of any given size to anything like this degree of accuracy.

In all cross bending tests of cast iron some means should be provided for accurately measuring the deflection of the bar up to the point of rupture. This can only be properly done by the aid of some kind of attachment to the testing machine itself. These deflections should be measured to the nearest $\frac{1}{1000}$ inch. The use of the deflection is to enable us to compute the resilience or elastic spring of the iron, as will be explained below.

Resilience of Cast Iron.—Resilience is a scientific term which signifies the toughness or the ability of the material to resist a shock or blow. It is not strength, neither is it deflection, but it is a property representing these two qualities combined. Thus if the total breaking load be multiplied by the total deflection of the beam, and this product divided by two, the result is the resilience of the beam in inch pounds, provided the load were measured in pounds and the deflection in inches. This product varies directly with the form and volume of the beam, irrespective of its dimensions, so that if the half product be divided by the total number of cubic inches in the beam, the result represents the resilience of the iron for a rectangular beam in inch pounds per cubic inch of metal. This is an absolute measure of the resilience or toughness of the iron, but it is easier to weigh the specimen than it is to compute its volume in cubic inches. Hence we may find the resilience of a rectangular beam per pound of metal by dividing the total resilience by the number of pounds in the specimen, just as before we found it per cubic inch by dividing by the number of cubic inches in the specimen. The writer prefers this latter method, and therefore he recommends the following:

Rule.—Multiply the breaking load in the middle of the beam by its deflection at the time of rupture and divide the product by twice the weight of the beam in pounds.

The result should be not less than 20 for ordinary cast iron, and may be as high as 50 for the best quality of refined cast iron, such as is commonly known as gun metal. For a very good quality of machinery castings, or such as should be used in railroad work, car construction, car wheels and the like, where the metal is subjected to severe shocks and blows, a result obtained as above of not less than 30 should be required. For stove iron a result not less than 40 should be specified.

In using the above method of making tests and computing the resilience of rectangular cast iron bars there is no necessity of carefully measuring the cross section of the bar, or its actual length. It should, however, be supported very near its ends, if the whole weight is to be taken in computing the resilience. It is also necessary to measure the deflection accurately. The only data, therefore, which need be taken are the weight of the bar in pounds, the breaking load in pounds and the deflection in inches. Applying the above rule to this data, we obtain at once the measure of the the toughness of the iron, which has been described as including both the strength and the deflection. If it is desired to know the strength alone, then it is necessary to measure the length, breadth and hight, and compute the strength per square inch by the formula

$$f = \frac{3}{2}\left(\frac{Wl}{bh^2}\right)$$

This value of f is called the "modulus of rupture" in cross breaking and is about one and three fourths times the real tensile strength.

Tension Tests.—In all tests of cast iron in tension the specimen should be cast round, free from all defects, and then turned down in a lathe throughout its entire length, the middle portion being reduced to a somewhat smaller diameter than the ends. It is necessary to turn down the end portion in order to allow the specimen to fit the grips perfectly, and the middle portion should be made somewhat smaller to insure against breaking in the grips. If the specimen be made 1¼ inches in diameter, and the rough casting turned down to 1¼ inches at the ends, and the middle portion reduced to 1 inch in diameter, we would have the ideal tensile test specimen for cast iron. The reduction from the end to the middle portion should be by a curved shoulder, and not by an angular offset, in order to prevent rupture at this point. The specimen should be some 12 to 16 inches long, and the ends which are gripped should be left about 3 inches long, the remaining portion being turned down to the uniform diameter of 1 inch. Such a specimen can only be broken upon a regular tension testing machine, such as few foundries have in their outfit, and hence these tests are not so well adapted to common practice as the cross breaking tests described above.

Cross Breaking Testing Machines.—Several concerns manufacture cross breaking testing machines which give indications of the deflection, such as are required in the application of the rule given above for determining resilience. In these tests it is very necessary that the load be put on slowly and with perfect uniformity, and this is accomplished in all these machines by means of a screw. Every foundry which undertakes to turn out a first class grade of cast iron should have one of these cross breaking testing machines in its outfit, and should study the character of all its mixtures by means of such tests as have been described in this paper, these tests being for both strength and resilience.

It must be noted that both the strength and the resilience can be determined from the same test. Having measured the length, breadth and height of the bar, and determined the breaking load, we can compute the breaking strength as described above; also having weighed the bar and determined its breaking load and its deflection, the resilience in inch pounds per pound of metal can be determined so that a single test in cross breaking fixes both the strength and the resilience or toughness of the iron. It must not be forgotten that these two qualities are entirely distinct, and must not be mistaken the one for the other. Thus, one mixture may be very strong and brittle, and another comparatively weak but very high in resilience. It is not impossible, however, to obtain both great strength and high resilience from the same mixture, and this, of course, is the ideal kind of cast iron. Such iron offers the greatest resistance, both to dead loads and heavy strains, and also to such shocks and blows as it may receive either in actual practice or from some accident.

Because the resilience of cast iron has not heretofore been commonly studied, or even thought of as a measurable property, is no reason why it should not be carefully examined into. This term is now coming into common use, and practical men must accustom themselves to its use and understand its meaning. If a manufacturer of cast iron would obtain one of the testing machines described above and carefully attend to the tests for resilience and compare his results with his mixtures, he could soon convince himself of the significance and importance of the resilience tests, and would probably never consent to grope in the dark in regard to the qualities of his products, as nearly all foundrymen have been accustomed to do. The character of his iron would then be no longer a matter of opinion, but would be determined absolutely, so that the proprietor could judge for himself of its quality from these tests and not have to rely implicitly upon the mere opinion of his foreman or superintendent. Furthermore, such tests as these cost very little, and any intelligent workman or clerk can be taught to make them and the accompanying computations.

To make such tests valuable a test record book should be kept, in which the mixture should be put down and the results of the tests alongside, and these carefully preserved. Such a record book of mixtures and corresponding tests would soon become of great value as part of the capital stock of the concern, and this knowledge would not disappear from the establishment when the superintendent took his departure: neither would there be any personal element in it, and it would in no sense be a matter of opinion, but would be an absolute measure of the quality of the iron, resulting from certain mixtures, which knowledge would be the common property of the entire establishment. There is probably no other way in which a small sum of money can be made to produce such valuable and permanent results in the carrying on of any foundry as in the making of such tests as here described and the careful preservation of the records.

The Efficiency of Gaseous Fuel.

In a paper by Mr. Matthewman before the West of Scotland Iron and Steel Institute, the author remarked that the question as to the economy, if any, effected by the use of gaseous fuel has long been one which has attracted considerable attention and called forth numerous valuable and interesting papers. This communication will be confined entirely to the consideration of the effect of the vapor of water upon the heating power of producer gas. For some considerable period it has been customary to enrich the gas produced in Siemens and other generators by replacing a portion of the air by steam, the decomposition of which produces two combustible gases (carbonic oxide and hydrogen), and, by decreasing the air supply, reduces the proportion of diluent nitrogen in the effluent gases.

In addition to the economy of heat arising from the decreased amount of nitrogen present, a further saving is effected in cases where the producer is far removed from the furnace, inasmuch as heat which would otherwise be carried off by the gas, and lost by the cooling action of the tubes and culverts, is utilized in the producer to effect the decomposition of the steam. There is, however, a limit to this use of steam, for if it were blown into the producer without being mixed with air (as is done in the manufacture of water gas), a very short time would suffice to cool the fuel by this abstraction of heat, and ere long the temperature would have fallen so low that no decomposition would be effected. The use of too large a proportion of steam with air acts in like manner, but in a less degree; part of the steam escapes decomposition and passes away with the gas. Further, the cooling of the producer consequent on the introduction of an excess of steam reduces the temperature below the strong red heat (or about 100° C.) which is necessary for the complete conversion of carbonic acid gas into carbonic oxide by contact with carbon. The amount of carbon wasted in the formation of carbonic acid gas is considerable, but the calorific value of the gas is not greatly impaired thereby, as the conditions which tend to increase the percentage of carbonic acid also produce a gas rich in hydrogen, and it is not until the effect of the water vapor is considered that the full extent of heat loss is realized.

During the conduction of the gas to the furnace through the usual cooling tubes and culverts a considerable proportion of the excess steam which has been supplied to a producer and escaped decomposition is condensed and deposited, but as in ordinary practice the temperature never falls below 100° C., much of the water passes with the gas to the furnace, detracting from the heating power by reason of the heat which it absorbs. The following results, showing the number of grams of water per cubic foot of gas, have been selected as representative of ordinary working, being taken from a considerable number of tests made at vorious works:

	Grams.
Aqueous vapor in culvert, at 150° C. mean temperature, taken throughout a day's work	2.90
Aqueous vapor in culvert, at 160° C., all fires recently cleaned	3.66
Producer burning dross, gas at 650° C., cleaned 22 hours, charged 2 hours	1.39
Producer burning dross, charged ½ hour, cleaned 27½ hours, gas at 600° C	5.35
Same fire 4 hours after charging and 3 hours after cleaning, 600° C	2.01
Same fire charged ½ hour, cleaned 17 hours, gas at 560° C.	4.36
Producer with grate, steam blower, cleaned 2 hours, charged 4 hours, burning coal, gas at 580° C	2.36

The average excess steam passing through the fire in ordinary working may be taken as about 10 lbs. per 100 lbs. of fuel; thus, the weight of a cubic foot of gas at the temperature of the experiments being taken as 0.061 lb., then 321 lbs. of gas would occupy 5,262 cubic feet, and as each cubic foot of gas contains 3 grams of aqueous vapor, the gas from 100 lbs. of fuel will contain 15,786 grams (or 32 lbs.) of water vapor. But the amount derived from the fuel, as shown by experiment, is only 22 lbs., and of this some is deposited, so that over 10 lbs. of steam pass through the fire undecomposed during the combustion of 100 lbs. of fuel.

In calculating the effects of these amounts of water vapor two methods may be adopted—firstly, to ascertain the number of heat units carried by the water up the chimney; and, secondly, to calculate the effect of various proportions of water vapor upon the theoretical flame temperature obtainable from the gas. The number of calories which the fuel is capable of developing is 613,400 per 100 parts, while those available in the 321 parts of gas produced only number 440,312, thus showing a loss in the producer of 173,088 heat units, or 28 per cent. of the value of the fuel. The number of heat units carried up the chimney by the water vapor may be readily found. Assuming the temperature of the escaping gases to be 530° C., and adding to the amount of aqueous vapor present in the gas that produced by the combustion of the hydrogen and marsh gas, it appears that 5 grams per cubic foot represent a loss by chimney (by aqueous vapor alone) of 44,320 calories—equal to 7.2 per cent. of the heating power of the fuel. Similar calculations, taking the amount of water in the culvert (2.9 grams), shows this quantity to cause a loss of 34,960 calories, or 5.7 per cent. of the heating power of the fuel.

In these calculations, and in those which follow, the specific heat of aqueous vapor has not been taken at the figures usually given, but has been corrected for the temperature according to the results of recent investigations on this subject by Mallard and Le Chatelier, the formula which these investigators deduced being further confirmed by a series of experiments conducted by the German Iron Smelters' Society and European Water Gas Company. By the use of the figures given by these experimenters the amount of heat imparted to the carbonic gas and water vapor is so much in excess of that which has hitherto been taken in similar calculations, that producer gas of average analysis gives a theoretical maximum temperature of only 1,400° C., in place of 2,000° C., as found by the old formula. As this is below the temperature of the Siemens furnace (which has been found by recent observations with the Cornu-Le Chatelier optical pyrometer to be from 1,500 to 1,600° C.), it is necessary to inquire into the effect of recuperation upon the intensity of the flame, the temperature of the gas and air as they enter the ports of the furnace being taken as 1,000° C. Under these conditions, the flame temperature of the particular gas under consideration is 2,145° C., if the effect of water vapor is omitted from the calculations. The water vapor produced by the combustion of the hydrogen and marsh gas is taken into account in every calculation, while, adding water equal to 5 grams per cubic foot, this is reduced to 1,930° C.

It is, however, not sufficient to consider only the effect of water vapor in the furnace; its action in the producer is also of importance. Reference has already been made to the cooling action of an excess of steam, whereby the fuel was cooled and the quantity of carbonic acid in the gas increased; it is therefore advisable to compare two gases—one produced under favorable conditions of work, and the other with excess of steam.

	A.	B.	
Carbonic acid	5	11	Composition by volume.
Carbonic oxide	30	16	
Hydrogen	11	19	
Marsh gas	5	5	
Nitrogen	49	49	
	100	100	
Water (grams per cubic foot)	1	5	

Calculated Temperatures.

		A.	B.
Without water	Gas and air cold, specific heat of products of combustion taken as at 1,400° C	1,575°	1,430°
	Gas and air 1,000° C., specific heats as at 2,000° C.	2,157°	2,050°
With water	Gas and air cold, specific heats as at 1,400° C.	1,510°	1,177°
	Gas and air 1,000° C., specific heats as at 2,000° C.	2,087°	1,792°

The foregoing table gives analyses of two such gases, and shows the theoretical temperature of each under various conditions. It will be seen that although the gas represented by analysis A contains 6 per cent. more combustible gas than that headed B, the calculated flame temperatures attainable when the gas and air are raised to 1,000° C. prior to combustion (that is, under the conditions of a regenerative furnace) are respectively 2,157 and 2,050° C. There is thus no great difference in the heating power of the two samples when judged by the analysis of their gaseous constituents, and it is not until the effect of the aqueous vapor present in each is considered that the inferior quality of gas B is fully realized.

The average theoretical flame temperature of producer gas burnt in a Siemens furnace is about 2,000° C., yet the temperature observed is only 1,580°. The reason for this is to be sought, as has been pointed out by Herr E. Blass, "not in the non development of the calorific power of the fuel in practice, but in retarded combustion owing to the gradual mixture of the air and gas, so that the heat is distributed over a large area with corresponding diminution of maximum intensity." If, then, with an available temperature of 2,000° C. only 1,580° C. is obtained, it is quite possible that if gas of the composition B were used alone a steel melting temperature would only be attained with difficulty, if at all. The analysis would scarcely be termed an av-

erage one, and it is probable that even a producer burning dross during a spell of wet weather would not produce worse gas, although the amount of water vapor present might be higher. This being so, and the flame temperature of the gas as calculated from the gaseous constituents being so good, it seems quite reasonable to ascribe the difficulty experienced in keeping up the heat of Siemens furnaces during wet weather to the increased amount of water vapor, derived, not only from the wet fuel but from the increase in the quantity of undecomposed steam, consequent on the cooling of the fuel in the producer. This hypothesis is all the more likely, as the figures given above have purposely been selected from fair average working, without having had regard to maximum amounts produced under exceptional conditions, the object of this paper being rather to show that ordinary quantities of water may appreciably lower the heating power of a gas than to draw attention to exceptional amounts which may at times be present. The results indicate that the effect of water vapor is so marked that its presence should be considered and more importance attached to the results than has hitherto been the case, particularly in view of the fact that recent practice seems in favor of dispensing with cooling tubes and introducing the gas into the regenerators at a higher temperature by building the producers nearer the furnace. One result of this would be that more water would be carried into the furnace, and perhaps under some conditions its quantity might be so excessive that the gas would be incapable of producing the temperature required.

The History of the Storage Battery.

Mr. Meyer Bloomfield asserts that no other science presents such a variety of subjects for toil and thought as that of electricity, one of the most important of which is the storage battery. Though the present applications of this battery are comparatively slight, its future usefulness seems so evident that it may be of interest to review its history alone, and to take a look ahead into the future.

The storage of electricity, or rather the possibility of creating and retaining a potential difference within a glass or metallic vessel, first evinced itself in the discovery of the Leyden jar, which occurred in 1745. But this discovery, further than to show the possibility of electrical storage, has but little to do with our subject.

The observation of polarization in a simple cell led to some experimental investigations by Ritter and Gautherot, in the early part of the present century, the result of which was that the latter, in 1801, demonstrated the principle of electrical storage by immersing two plates of the same metal in acid, and having subjected them to the action of an electric current in one direction, connected the plates to a galvanometer and observed the production of a secondary current in an opposite direction.

In 1842 Grove constructed a gas battery, on the principle that the oxidization of the copper anode in an electrolytic cell produces electrical storage, which consisted of a three-necked flask, containing acidulated water, into which was inserted two inverted tubes containing respectively oxygen and hydrogen. Platinum wires sealed into the upper ends of these tubes were connected with platinum electrodes in contact with the gases above and the water below, thus the external circuit was completed through copper conductors whose terminals dipped into mercury cups. When the circuit was closed the gases recombined to form water, thus generating an electric current, which in the cell flowed from hydrogen to oxygen and externally from oxygen to hydrogen; and whose E.M.F. was equal to that required to electrolyze water, so that the storage of electrical energy by chemical decomposition was recovered by chemical recomposition.

Other investigations followed, but in 1859 Gaston Plante's discovery of the special adaptation of lead plates for this purpose, opened the way for the practical use of electrical storage. Plante constructed a cell using as electrodes two large sheets of lead rolled together and electrically insulated from each other by strips of gutta-percha. They were then immersed in acidulated water, in a tall glass jar, and subjected to the action of a battery current supplied by two or more cells. The chemical reaction which followed resulted in creating a difference of potential between the terminals which manifested itself in the discharge of the cell.

The tedious and expensive process requisite for the electrical formation of Plante's plates led to the invention of Camille A. Faure, about 1880, of plates prepared by covering sheet lead with a paste made of red lead and sulphuric acid; the coating being confined to the surface by a covering of paper and by felt placed between the plates, which also served the purpose of insulation. Thus prepared and rolled together, they were placed in a glass jar with acidulated water, and the coating subjected to electrolysis and with alternation of current, was, in a few days, changed to a spongy lead of different chemical composition than at first, the cell then being ready for practical use.

While the Faure cell could be produced much more economically than the Plante, and was equal to it in electrical energy, it had such serious defects that its utility was circumvented. The felt preventing the free circulation of the current, and seriously impeding electrolysis, it soon became corroded by the acid and partly removed in patches, and ceased to insulate. The coating failed to adhere properly, sloughed off, and fell to the bottom. Hence, in a short time, the cell proved worthless. But its invention serving to direct the attention of men like Brush, Swan and Sellon in this field, resulted in the inventions of many greatly improved storage batteries.

The storage battery of to-day, though not perfect, has nevertheless rendered much valuable service. Its applications are varied, and while not as yet very extensive, they are sufficient to indicate that storage batteries may, in the near future, occupy a very important place in the electrical industries. A fortune awaits the lucky man who invents a storage battery that will overcome all of the objections to those now in common use; and can confine electricity in considerable quantities within a small vessel, which will ever be ready to do man's bidding. Verily, the field of the future application of the storage battery is a vast one.

Medicaments Derived from Coal Tar.

Le Genie Civil says that as a consequence of the progress made in the manufacture of coloring materials from coal tar, physiologists and physicians have been able to experiment with a host of new products, some of which have found a place as therapeutic or antiseptic agents. The substances submitted to such experiments are of very diverse nature, but there is observed in them, nevertheless, a limited number of characteristic groupings. They are phenols, acetylated amines and sulphonated sulphureted, iodated and chlorated derivatives of the aldehydes. Methodical experiments have not been numerous enough and the data furnished by biological chemistry are not precise enough to allow us to establish any relation between the constitution of these bodies and their physiological properties, provided any exists. Their applications, in fact, exhibit many anomalies. We see products that are very different as to constitution act upon the organism in a similar manner, and substances that are analogous, from a chemical point of view, produce very different therapeutical effects. With the information that we possess upon this subject it is hazardous to draw absolute conclusions.

The number of organic bodies proposed as antiseptics or as medicinal products is very large, and one or more new medicaments are observed to make their appearance every day. We can mention but a limited number here, in selecting the most important of them.

We have arranged these substances as antithermics and analgesics, and hypnotics and antiseptics. There is nothing absolute about this classification. A large number of these products has at the same time several of these properties. For example, chloral, which we place among the hypnotics, is an analgesic, and is even employed as an antiseptic, and asaprol is at the same time an antiseptic and an analgesic.

1. *Antithermics and Analgesics.*—Of all the artificial antithermics, *antipyrine* or *analgesine* is the most widely used up to the present. It is derived from phenyl-hydrazine, which is itself obtained by dinitrating aniline and in reducing the dinitro benzol thus obtained. This phenyl-hydrazine is afterward condensed with aceto-acetic acid, and then, finally, the product is submitted to a methylation. We have at last the dimethyl-phenyl-pyrazolon that constitutes antipyrine. It is very soluble in water, and this property permits of administering it under the most varied forms—a quality that is highly appreciated in pharmacy. It must be observed, however, that, as a general thing, solubility has no relation whatever with the quickness of action and assimilation of a medicament. Phenacetine, while being but slightly soluble in water, acts nevertheless as quickly as antipyrine.

The success of antipyrine has evoked a series of experiments with the object either of preparing substitute antipyrines and of analogous pyrazolons, or of associating it chemically with other substances. In the first order of ideas has been produced *tolypirine*, which is a paramethylated antipyrine in the phenylic nucleus, and then chlorated, bromated, etc., antipyrines. In the second series antipyrine has been associated with salicylic acid, and this has given *salipyrine*. *Tolysal* is the salicylic combination corresponding to tolypyrine. Apropos of hypnotics, we may mention *hypnal*, which is a derivative of antipyrine and chloral.

Thaline and *kairine* are quinoleic products that have been proposed likewise as antiseptics.

Among the oldest analgesics and antithermics, we find *acetanilide* and *antifebrine*, which are prepared by treating aniline with anhydrous acetic acid. If, instead of operating with aniline, we start from hydroxylated aniline, that is to say, from a product which is both phenol and amine, and etherify it before acetylation, we shall have *phenacetine* or *phenedine*.

Thymatecine is the phenedine of thymol, and *exalgine* is derived from the acetylation of methyl-aniline.

Salicylate of soda has been for some time employed as as an antirheumatic. Salicylic acid is a carboxylated phenol, that is to say, a body that is at once phenol and benzoic acid. It is prepared by passing a current of carbonic acid over phenate of soda at a high temperature. Several applications have been found for its derivatives, among which may be mentioned salipyrine, that we have spoken of above, and salol, which we shall find among the antiseptics.

Asaprol has the same action as salicylate of soda. It is obtained by treating beta naphthol with sulphuric acid at a low temperature. It is the sulphuric ether of beta naphthol. It is offered in the state of calcium salt very soluble in water. Under the name of *abrastol* it has been used as a microbicide.

2. *Hypnotics and Various Medicaments.*—One of the most frequently employed hypnotics is *chloral*, which is the hydrate of trichlorated acetaldehyde.

An endeavor has been made to associate it with various organic substances. In this way have been prepared: *Chloralose*, which is a combination of chloral and glucose; *hypnal*, which is due to the union of one molecule of antipyrine and one of chloral; and *somnal*, which is obtained from chloral and urethane.

Sulphonal is likewise a very efficacious hypnotic, but its constitution has no relation with that of chloral. Chemically, it is called the diethylsulphone of dimethyl methane. It is formed by the combination of acetone with ethyl-mercaptan. *Trional* and *tetronal* form part of the same series.

For skin diseases there have been proposed *dermatol*, which is the subgallate of bismuth; *sulphaminol*, obtained by the action of sulphur upon meta oxidi phenyl amine; *resorcinol*, which is a combination of iodoform and resorcine; and *lysophane*, which is chemically called triiodo-meta-cresol.

Tumenol, *thioilne* and *sulphonated thiopene* are designed for the same use.

Piperazine, a nitrated product of the closed chain series, is diethylene diamine. One of the processes of preparing it consists in causing ammonia to act upon bromide of ethylene.

Orexine serves to stimulate the appetite. It is a hydrochlorate of phenyl dihydro quinazoline.

3. *Antiseptics.*—Among the organic antiseptics, we find, especially, bodies with phenolic and aldehydic functions, and halogenated derivates.

Phenol, *beta-naphthol* and *gaiacol* are characterized by the phenolic grouping OH directly connected with the benzolic or naphthalic nucleus.

The use of a large number of phenolic derivates has been recommended. Thus, *salol* is salicylate of phenol, and *betol* is the salicylate of beta-napthol. The union of benzoic acid with napthol gives *benzonapthol*.

Abrastol, of which we have above spoken under the name of asaprol, is the salt of calcium of the sulphuric ether of beta-napthol. It is a microbicide at present proposed for the preservation of wine.

Among the phenolic products of less importance, we may mention *alumnol*, *sozal*, *daptherine*, *phenoline*, *cresine* and *microcidine*. *Iodoform* is triodated methane, analogous to chloroform as regards constitution. This antiseptic has, as well known, an insupportable odor. An endeavor has, therefore, been made to substitute odorless and likewise iodated substances for it. Among the bodies proposed to this effect we may mention *diiodacetyiene* or *diiodoform*. In order to prepare this alkaline hypoiodites are made to act upon an aqueous solution of acetylene, or water upon a mixture of iodine and carbide of barium, or else by treating acetylene with iodine in the presence of an excess of potassa at a low temperature.

There likewise exists a *tetraiodo-acetylene*. The other iodated derivatives are: *Traumatol* (iodo cresylol), *aristol* (iodo-thymal), *iodol* (tetraidopyrol) and *sozoidol* (diodo-paraphenate of sodium).

Formol, which has recently been proposed as an antiseptic, is form aldehyde. It has the great advantage of being volatile, and, consequently, of penetrating to the very interior of the objects to be disinfected.

Ichthyol, *anytine*, *thiol* and *thiolinic acid* are sulphonated and sulphureted derivates of organic and mineral oils employed in this state and that serve as solvents for products insoluble or but slightly soluble.

Among the substances mentioned, a small number will doubtless receive the sanction of practice, but the road is laid out. On the one hand, syntheses are multiplying with the object of finding new series, and, on the other, the natural alkaloids are the object of numerous studies. With the means now at the disposal of chemistry, it is possible to study the active principles of digitalis, belladonna and a host of other natural products. We shall certainly succeed in giving such alkaloids a greater energy, perhaps new properties, and even replace them by substances of which the syntheses will be only the results of a study of the products, of their reduction and of their decomposition.

The Testing of Portland Cement.

According Mr. Pierre Giron, the adoption of more rigorous rules for testing Portland cement is to be desired, for the protection of engineers and architects, and to encourage those whose efforts are to give to the trade a more valuable product. The first point to be considered is the fineness of grinding. For this test three sieves are necessary, Nos. 50, 80 and 200. Weigh accurately 100 grammes of cement. Pass it through the finest sieve (No. 200); the residue, being weighed, will give at once the percentage upon the sieve. What passes through a No. 200 sieve is the impalpable portion of the cement. The residue on No. 200 sieve is then thrown on a No. 80 sieve, and what is left, being weighed, constitutes the percentage of residue upon sieve No. 80. The residue on a No. 80 sieve is finally thrown on No. 50. What cannot pass through this sieve is weighed, and constitutes the percentage of coarse grains in the cement. A well made Portland cement will leave nothing on a No. 50 sieve. The residue on No. 80 will be from 5 to 7 per cent., and from 25 to 30 per cent. on No. 200. Some brands of Portland cement will leave from 15 to 20 per cent. of residue on a No. 80 sieve, and from 40 to 50 per cent. on No. 200. Those cements should be rejected. The inspection of the residue will indicate the quality of the cement. The presence of particles of coal shows that the selection of the clinkers has been carelessly done. Soft yellow grains show that underburned clinkers have been mixed. The residue should be composed of nothing but hard black grains with sharp angles.

The specific gravity of Portland cement is between 3.050 and 5.175. It can be determined very accurately with various apparatus. The sample should not be sifted beforehand, but treated as it is. The presence of foreign matter, even in small amount, can be at once detected by the specific gravity test. The most common adulteration is to add slag to the cement. But as the density of slag is only 2.8, it follows that an objectionable proportion of slag in the cement would lower its density below 3.05, which should be considered the lowest that can be tolerated.

As to chemical composition, it is advisable to have the cement analyzed, as it will give valuable information on the product. Analyses made from English, American, German, French and Belgian cements show that the quantity of each element varies between the following limits: Silica, 20.50 to 26.10 per cent.; alumina, 5.20 to 10.60 per cent.; oxide of iron, 2.10 to 5.30 per cent.; lime, 51.20 to 67.31 per cent.; magnesia, 0.33 to 2.80 per cent.; sulphuric acid, 0.26 to 1.78 per cent.

The degree of hydraulicity, which is determined from the chemical composition, is the first thing to be considered. The relation between the silica and alumina on one hand and the lime on the other constitutes what is called the "degree of hydraulicity." It should not be below 0.43, and when the cement is to be used on work in sea water it should be raised to 0.46. Oxide of iron should not exceed 4 per cent. In some specifications a higher percentage of oxide of iron is considered unsafe. Magnesia must not exist beyond 3 per cent.; any cement having more should be rejected. Magnesia cements give very good results in tensile strength, and work done with them may look very well for several months and even several years, but in the course of time swelling takes place, and with such force that nothing can resist it. Even 1 per cent. of sulphuric acid would be dangerous if the cement was used in sea water. In soft water or in the air, however, the presence of 2 or 3 per cent. of sulphate of lime has no injurious results.

The initial setting of Portland cement, gauged neat, should not begin before 30 minutes, and the final setting should not take place before 3 hours. In the case of imported cements, which may be from 3 to 12 months old, it will take sometimes 12 hours, or even more, before the sample gets hard. A more freshly made cement will usually set in 4 to 7 hours, and this is more satisfactory. Of all the qualities in cement, the setting is the most difficult to regulate. A carefully made cement may sometimes be very quick setting, while an inferior cement may be very slow setting. Nevertheless slow setting is almost essential in Portland cement, and manufacturers can always, in the case of a well made cement, make it slow setting by exposing it to the air in thin layers.

The test for stability in volume is an important test, and should never be omitted. Briquettes or cakes of pure cement, 24 hours after gauging, are immersed in boiling water; if the samples show no alteration at the end of 6 or 12 hours, the cement may be considered perfectly safe. A dangerous cement will disintegrate or blow. The test for hydraulicity in cold water is no longer considered reliable by experts. Boiling water will bring out in a few hours the effects of free lime. An excess of sulphate of lime may also cause the disintegration of the cement, especially in sea water. A solution of calcium chloride at 40 or 60 gr. of anhydrous salt per liter should be used to mix the cement, and the samples immersed after 24 hours in the same solution. If the cement contains from 3 to 4 per cent. of sulphate of lime, at the end of a few days the samples will show signs of cracking.

For tensile strength briquettes of one square inch section are almost universally used now. The quantity of water mixed with the cement has much influence on the tensile strength. An excess or a deficiency of water is equally injurious. The proportion of water to be used may be from 20 to 30 per cent., according to the nature of the cement. The paste ready to be put in the molds should be stiff, brilliant and plastic. The 24 hours' test has no value. Briquettes are broken at the end of 7 and 28 days. Neat cement should stand at least a strain of 400 lbs. without rupture at 7 days and 500 lbs. at 28 days. It is not uncommon to see certain brands giving much higher tests. Portland cements of superior quality, when tested neat, show a rapid increase of strength, and the maximum (from 800 to 900 lbs.) is attained in a few weeks or a few months. Cements of inferior quality test low in the first period of hardening; they may increase in strenth, in the course of time, but they will never test as high as the best. It is preferable in practice to use cements which set slowly and harden rapidly. The work is thus in a short time protected against deterioration. The greater the initial strength the surer the success of the work. Cement is never used neat, however, and the strength of a neat briquette after a long time presents but little interest. The strength of cement mixed with sand is much more important.

To test the tensile strength, a mixture in equal parts of sand and cement will attain the same strength as pure cement; and even with some sands of good quality the mixture would test higher than neat. If a sand briquette is immersed in water for a few days only and then left in the air the tensile strength will be considerably higher than if the samples had always been under water. The same results occur in practice; and all masonry works should be, as far as possible, kept wet during the first few days.

For the sand test a standard sand, made of crushed quartz should be used. The mixture of three parts of cement to one of sand, by weight, has been adopted everywhere, and should be adhered to for the sake of comparison. Much difference of opinion exists as to the amount of water to be used and the manner of filling the molds. In Europe the official rules prescribe generally 10 per cent. of water. A sufficient quantity of mortar to fill one mold is weighed, and this is pressed firmly with a guide and a hammer until the water appears at the bottom of the mold. In America a little more water is used, and the mortar is filled loosely in the mold. There is no compression of the mortar except what the operator may apply with the trowel. The object of the European mode of testing is to bring out all the strength there is in the cement, and to do so by mechanical means, which are constant and independent of the skill or experience of the operator. The results of this method agree very closely. The American system of testing comes nearer to the practical use of cement, and engineers give it the preference on this account. But by this method the sand tests differ widely, and it is difficult to form an accurate opinion of the comparative value of a given brand. A mixture of 3 parts of standard sand to 1 of cement, under the American mode of testing, should give a minimum tensile strength of 125 lbs. in 7 days and 175 lbs. in a month.

Elaborate and expensive apparatus is used in Europe to estimate the crushing strain that cement should stand, and in the official specifications the results of this test are considered more important than those from tensile strength. Tests are also made for bending strength with a bar made of mortar, having a standard length and section; for imperviousness, by means of water pressure; for adherence, with blocks of mortar on marble or glass plates. But these tests have not yet been adopted in the United States, and they offer no particular interest, except for special researches.

THE Metropolitan Electric Company, at Reading, Pa., is putting up a new power station, and has placed the contract for the iron roof and travelling crane with the Berlin Iron Bridge Company, of East Berlin, Conn.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Helena (Arkansas) Electric Light and Power Company's plant was sold at auction early this month by the Receiver, Mr. S. S. Faulkner, by the order of the Court. It was purchased by the Helena Gas Company, which will remodel the same and operate it hereafter in connection with the gas plant.

WE are indebted to a St. Louis correspondent for the following: "*A Corner-Stone Laying.*—The custom of dedicating buildings erected for religious and educational purposes by installing a corner-stone appropriately inscribed has been followed almost from time immemorial. With the many advantages which commend this custom, there seems to be no reason why an edifice dedicated to the task of dispelling material darkness should not share in the practice equally with those whose office it is to diffuse mental and spiritual light, even though the first named be only a retort setting. In consequence, nothing need appear incongruous in the ceremony which took place at the Laclede Gas Light Company's Station 'B,' on June 9th, in the laying of a corner-stone for the new stack of benches now being installed at that plant. The stone itself was a block of granitoid, formed in the northwest corner of the buttress wall of the stack, below the fire line, and inclosing a tin box, which contained certain papers of presumable interest to their Twentieth Century discoverer. The first paper gave the list of the others, and read as follows: '*To the officer who may be in charge when this box is uncovered:* The year 1894, A.D., greets the year ?—Within this box are inclosed the following papers, etc.: Copy of the St. Louis *Republic*, June 8th, 1894; copy of the St. Louis *Globe-Democrat*, June 8th, 1894; report of operations at Station B, for 24 hours ending 7 A.M., June 8th, 1894, and chart showing street pressures for that day; list of officers of Laclede Gas Light Company, and department staff at Station B; copy of the *Gas World*, distributed by the Laclede Gas Light Company; copy of pamphlet distributed by Laclede Gas Light Company in its campaign of education of gas consumers; constitution and by-laws of the Gas and Electric Building and Loan Association, and copy of financial statement of same for January, 1894; constitution and by-laws of Western Gas Association, with list of officers and members for 1893; pamphlet with papers for consideration at 17th annual meeting Western Gas Association, Cleveland, Ohio, May 16th to 18th, 1894; specimens of gold, silver, nickel and bronze coins in circulation in the United States, A.D. 1894.' Then followed the other papers in the order named, until the specie packet was reached, which was thus inscribed: 'June 8th, 1894. It has been customary, when consigning a box such as this, to its (presumably) long rest in the heart of the corner, to place within it, among other articles of interest, certain coins of the realm. Not to disregard so well-established a precedent, we would submit that the following denominations should prove sufficient to indicate to the latter day discoverer the range and character of our present medium of exchange: *Gold*—Double eagle, $20; eagle, $10; Five dollar piece, $5; two and one-half dollar piece, $2.50; one dollar piece, $1. *Silver*—Dollar, $1; half dollar, 0.50; quarter dollar, 0.25; dime, 0.10. *Nickel*—Five cent piece, 0.05; three cent piece, 0.03. *Bronze*—Two cent piece, 0.02; one cent piece, 0.01. After much earnest consideration, however, it has been decided that it would not be well to hazard a collection of these coins in a spot of such questionable safety as this may become; and in lieu thereof is inclosed a letter to the United States Mint, where a full issue of the coins may be seen, and whose specimens are in much better condition than those we have been able to obtain.' The ceremony was commenced at 3 P.M., in the presence of a distinguished company, including several general officers of the Laclede Company, most of the foremen of departments at Station B, and also a delegation of masons—Bricklayers' Union, No. IV. A brass band (on the engine cylinder) was also at hand. After the completion of the ceremony of inclosing the box and block, a champagne bottle (extra dry, inside) was broken across the buttress corner, and this sentiment was offered: 'The success of the new benches; may they give substantial aid in making the shadows ever grow less.'"

DISPATCHES from Kalamazoo, Mich., are to the effect that a syndicate of Detroit and Kalamazoo capitalists, failing to secure by purchase the plant and franchises of the Kalamazoo Gas Light Company (for which it is said they offered $125,000), have succeeded in obtaining control of the franchise issued in 1887 to the Kalamazoo Natural Gas and Fuel Company, and will operate the same under the name of the Citizens Gas Company. The Company is capitalized in $100,000, and some of those interested in its fortunes are: E. P. Ross, Frank Henderson, O. M. Allen, Homer Manvel, H. P. Kauffer, M. H. Lane and J. T. Lynn, of Detroit. We understand that Mr. Lynn is to act as General Manager

of the Company, and that a plant of the modern water gas type will be constructed. A site on Harrison street, running back to the Kalamazoo river, has been selected, and while it is said that no further attempt to secure control in the old Company will be made, it is not at all impossible that such a thing will eventually be accomplished.

A FEATURE of the Forty fourth Annual Commencement of the Columbus (O.) High School was the reading of an essay on "The Manufacture of Illuminating Gas," by Miss Ida E. B. Mees. Her descriptions of the different stages of manufacture and distribution were very accurate and quite technical, and were illustrated by charts and drawings compiled and designed by the essayist as the result of her own observations in the works of the Columbus Gas Company.

THE following, from a recent issue of the Philadelphia *Record*, is well worthy of study, as a positive proof of the "slowness" of the gas business in the Quaker City: "Since the reduction of the price of gas from $1.50 to $1 per 1,000 cubic feet, the Department of Public Works is confronted with the fact that a decrease in the amount of gas consumed is shown by the records, as well as the expected decrease in revenue consequent upon the reduction in price. According to the returns at the Bureau of Gas, the bills sent out in the month of May, 1893, when the gas was $1.50, show the following figures in the districts which receive bills in that month:

District.	Consumption, Cu. Ft.	Amount.
North	68,800,000	$103,200
West Philadelphia	24,760,000	37,140
Monthly	25,870,000	38,805
Spring Garden	59,260,000	88,890
Kensington	34,550,000	51,825
Totals	213,240,000	$319,860

"For this year, the May bills, with dollar gas, give these figures:

District.	Consumption, Cu. Ft.	Amount.
North	59,000,000	$59,000
West Philadelphia	18,400,000	18,400
Monthly	32,100,000	32,100
Spring Garden	62,000,000	62,000
Kensington	34,000,000	34,000
Totals	205,500,000	$205,500

"The largest decrease in consumption is in the North district, where it falls off over 8,000,000 cubic feet. This is one of the wealthiest localities in the city, comprising, as it does, the territory between Market and Vine streets and the two rivers, and it is the theory of the gas officials that the number of residences and business places lighted with electricity has largely increased. It is thought that the reduction in consumption in other localities is caused by the hard times, which forced many people to abandon gas and use oil as an illuminant. There is an increase among the class of consumers who receive monthly bills, which to some extent is an offset to the decrease. The decrease, however, amounts to about $114,000 in the city's revenue."

MR. G.W. DUN, the naturalist, of San Francisco, Cal., referring to a probable cause for the extinction of many "night gas lights" in that city, says: "The moth miller is causing many deaths, and people would do well to look out for them. They are harmless looking, but very dangerous. San Francisco is, though a large city, full of these moth millers. The average man does not see a moth miller, though it flies before him half a dozen times. He has not trained eyes for such things. The only way he knows the millers have been around is when he discovers his clothes cut to pieces. It is the millers rather than the little gusts of wind that put out the gas. As soon as a moth sees a light it makes for it. Most people on going to bed leave a jet or two burning very low. At the same time the window sash is up or down; therefore, when a miller sees the jet he finds easy access to it. A single flip of his wings is often enough to extinguish it. The result is that the gas quickly fills the room and asphyxiates the sleeper. No wonder that no note is left and no reason can be assigned for the death. It is a mystery for which the moth miller is responsible."

ALPHONSUS P. CLOUTIER, a musical instructor at St. John's Academy, Indianapolis, Ind., has instituted suit for damages against the Indianapolis Gas Company and the Indianapolis Consumers Gas Trust Company. According to the bill presented to the court by the complainant, on December 25th, 1893, he stepped into the cellar of the academy, with a view to locating a gas escape, and while there ignited a match. The ignition was followed by an explosion, complainant suffering severe bodily injuries therefrom. He claims that the defendant's pipes were faultily and negligently overseen, and asks that he be awarded $25,000 damages for the injuries sustained.

THE proprietors of the Grass Valley (Cal.) Gas Company have notified their consumers that hereafter the gas rate will be $6 per 1,000 cubic feet, an increase of $1 per 1,000.

THE following letter explains itself—we print it gladly, with the further remark that it is to Mr. Edson's credit that he is not connected with the concern named:

NO. 433 PRODUCE EXCHANGE,
NEW YORK, June 19, 1894.

To the Editor AMERICAN GAS LIGHT JOURNAL:—I am informed you have mentioned my name in your paper, dated the 18th inst., as one of those most largely interested in the Canisteo Electric and Fuel Gas Company. I have not seen the paper, but have no doubt the information is true. Therefore, I wish to say that I am not and never have been, interested in that Company, or any other gas company in that part of the State. Yours truly, FRANKLIN EDSON.

THE Boston *Journal* says there are five candidates for the vacancy in the Board of Gas and Electric Light Commissioners. Essex county brings forward the editor of the Haverhill *Bulletin*, and he has the indorsement of General Coggswell, District Attorney Moody, the Essex Senators and other representative men. Mr. Warren Hoyt's chances are quite promising. Boston has a candidate in the person of Mr. Rust, while the New Bedford district favors ex Postmaster Gifford. Mr. Towne, of Orange, has a Grand Army indorsement, and Messrs. Smith, of Colerain and Ackley, of Fitchburg, are also on the list of candidates.

THE Perth Amboy (N. J.) Gas Company has reduced its selling rate to $2 per 1,000 cubic feet. Consumers of 5,000 cubic feet or over in any month are granted a special discount.

IT pleases us to say that the Bristol Recording Pressure Gauge is meeting with great favor and gives great satisfaction to every gas man who has tried it. Over 400 of those useful and reliable instruments have been put upon the market, and have found working places in all sorts and conditions of gas plants. As a continuous recorder of street main pressures it cannot be excelled.

MR. WM. A. ALDRICH, writing to the JOURNAL, from Bloomfield, N. J., under date of the 18th inst., says: "I regret that Mr. McDonald should have spoiled an otherwise interesting paper, by referring to a comment of mine on Mr. Anson's paper on meter testing, read before the Ohio Gas Light Association, where he stated that out of 5,000 meters tested not more than one fifth of one per cent. was out. Mr. Anson is to be congratulated on finding so doughty a champion. My contention was, and is, that for a proper test of a meter, gas and not air should be passed through it, unless corrections be made for the difference in specific gravity between coal gas and air."

MR. JAMES WILLIAMS, the veteran Superintendent of the Johnstown (Pa.) Gas and Water Company, recently celebrated in appropriate fashion the 76th return of his birthday. Although well beyond the three-score and-ten limit, Mr. Williams still keeps sharp eyes and active hands on the Company's properties, which have successfully stood out against flood and fire.

AT the annual meeting of the shareholders of the Reading (Pa.) Gas Company the following Directors were chosen: David E. Stout, Chas. Breneiser, E. D. Smith, William A. Arnold, Isaac Hiester, William R. McIlvain and Horatio Trexler; and the Directors subsequently elected Horatio Trexler to the Presidency.

S. A. DUNCAN, Receiver of the Monongahela Electric Light and Power Company, of Homestead, Pa., announces that he will sell all its belongings, real and personal, at auction, at noon of July 5th, in front of the Allegheny county court house. A good deal of money was sunk in this venture.

THE new rate at Wilkes-Barre, Pa. ($1.10 per 1,000 cubic feet), has gone into effect, and Brother Smith is thinking of ordering gas cooking ranges by the carload.

THE Massachusetts Board of Gas and Electric Light Commissioners have named July 11th as the day for the first taking of testimony on the hearing of the petition for an order to reduce the gas rate at Worcester, Mass. Senator Hoar has agreed to represent the Company during the hearing.

UNDER the bid of the Oakland (Cal.) Gas Light and Heat Company (which was accepted by the authorities), the lighting is to be performed on the following basis: Arc lamps (2,000-candle power), 46 cents each per night; gas lamps, 12½ cents each per night—an all night and every night table to be followed. The lighting of the public buildings is arranged for as follows: Arc lights (2,000-candle power, to midnight), 40 cents each per night; gas, $2 per 1,000 cubic feet; incandescent electric lamps (16-candle power), 5 cents each per night.

WM. J. W. GOAD, on behalf of the Colusa (Cal.) Gas Company, offered to supply any number of gas lamps on public account, on the basis of the payment therefor of $3 per post per month, the Company to light, extinguish and clean. The proposition was accepted, although Trustee Hawkins demurred on the ground that the rate was too high.

MR. R. M. BIDDLEMAN, of Adrian, Mich., Secretary and Superintendent of the Petroleum Light and Heat Company, has just completed the new plant ordered by the Martinez (Cal.) Gas Company.

THE Indianapolis *Sentinel* says that the city administration has finally made a move in the direction of taxing the natural gas mains, the Finance Committee of the City Council, at a meeting held June 13th, having then considered the communication of the Mayor's cabinet to the Council, which communication was handed to the Council something like eight months ago. The result of the discussion was the adoption of a resolution directing the City Attorney to prepare the necessary ordinance. When this shall have been sent to the Council, the Gas Company will be given a hearing.

THE Manchester (N. H.) *Union* says: "The Superintendent of the Laconia (N. H.) new Gas Company, Mr. William Tarbell, of Waltham, Mass., is busy laying the gas mains through the city's streets, 60 men being engaged on the work. Mr. Tarbell does his work in a manner that excites favorable comment from the citizens, for, unlike many others who have done similar work in the past, he leaves the highways in a better condition than he found them. The holder is being erected on the Messer street site, and the brick building to house the gas apparatus will be started soon, and the Company hopes to have everything completed by September 1st. Mr. John O'Laughlin, the Agent of the Company, has the general supervision of the Company's interests, and he seems determined to give the citizens a much needed gas service."

THE Hornellsville (N.Y.) gas works were sold, under legal proceedings, taken, we believe, for the purpose of settling an estate, the price being returned at $27,000.

CONGRESSMAN FLETCHER has introduced a bill in Congress giving the Minneapolis Gas Company the right to lay a submerged main to carry gas from its works on the west side of the Mississippi river to the east side. The main is to be located between the Falls and the Washington avenue bridge, and the plans are to be subject to the approval of the Secretary of War.

THE consumers of the Keystone Natural Gas Company have been notified that at a certain stated time meters are to be placed in each house supplied with gas. At present the supply is carried on at so much per month per stove.

THE public lighting of Camden, N. J., has been disposed of for the next five years on the following basis: Gas lamps, $19.75 each; arc lamps, 38 cents each, per night; incandescent electric lamps, 24 candle power each, $20 per year. There are only 45 lights of the incandescent type in use.

WE desire to acknowledge the receipt of a copy of the handbook recently published by the Pettingell-Andrews Company, of Boston, Mass. It contains much that is valuable to the constructor of electrical railways.

IT is quite on the cards that a notable reduction will soon be ordered in the selling rates at Jersey City, N. J.

MR. V. L. ELBERT is gradually putting things in order at Menominee, Mich.

THE Spencer (Mass.) Gas Company is enlarging the steam power division of its electric lighting department.

AT a special general meeting of the shareholders in the Consumers Gas Company, of Montreal, it was resolved to increase the capital stock from $500,000 to $750,000, the addition to be allotted in "such manner as the Directors of the Company shall deem best."

ADVICES from Kittanning, Pa., are to the effect that in the matter of the injunction case brought by the Borough of Freeport to restrain the Philadelphia Gas Company from laying a line of pipe through the streets, Judge Rayburn issued a final decree in favor of the Company. The Court stated that by the act of 1871, under which the defendant Company is incorporated, it can lay such a line without the consent of Councils. An appeal to the Supreme Court has been taken.

Engineers as Correspondents.

Mr. W. H. Wakeman, in the *Safety Valve*, says that the editor of a mechanical journal sat in his easy chair awaiting the morning mail and wondering what new puzzles it would bring to him, while longing for the time when typewriting machines shall be exclusively used. The postman entered, left a large bundle of letters and departed. The editor began a perusal of them in an interested way, for he was in love with his occupation, and considered each correspondent a personal friend.

The first one that he opened was from a fairly intelligent engineer, who wrote a good hand usually, but as he approached the foot of the page he began to contract the space given to each word, as he evidently wished to get all of his letter on one page. When the last line was filled, he reversed the sheet and wrote across the top of the page in letters so small as to be scarcely legible, as the words were so close together. When this space was packed full there was still more to be said, so the sheet was turned partially around and a few lines written along the edge of it, crossing some of the words on the regular lines. This correspondent complied with one of the requests frequently made by editors, for he wrote on one side of the sheet only, and he did not figure so closely as to wish to save a sheet of paper, but he was not thoughtful enough to write on one page until it was filled without crowding, and then take another sheet and finish his communication on it.

The next envelope contained a pair of indicator diagrams, and the engineer who sent them wanted to know what mean effective pressure they showed, but as he did not mention the number of the spring that was in the indicator when the cards were taken, the editor could not answer the question.

Another engineer wanted to know how much power his engine was developing, and enclosed a pair of diagrams from it, but he did not give the diameter of the piston of his engine. This being one of the most vital factors, the absence of it made the other data of no value whatever, and so there was another disappointed correspondent.

Another man wanted to know just how much power his boiler was developing, giving the dimensions of it in detail, but apparently thought that a boiler must be developing a stated amount of power at all times, regardless of variation in the power required in the factory, for he did not tell how many pounds of water were evaporated into dry steam in a given length of time, nor the temperature of the feed water, both of which are necessary in determining the power developed.

Still another wanted to know how much pressure he could safely carry on his boiler, but did not tell whether the plates were the same thickness throughout, or if they were badly corroded in places, neither did he tell the diameter and pitch of the rivets.

Another letter came from a man who wanted to know what size of injector he should purchase for an 80-horse power boiler, but did not state whether it was developing more or less than 80-horse power, nor give the amount of coal burned in a given time.

A fireman wanted to know why his pump failed to work, but gave no particulars that would enable the editor to give an intelligent reply.

A machinist wished to be informed as to the amount of power that a 24-inch belt would transmit, but did not state whether it was single or double, nor tell if the pulleys were wood, iron, or iron covered with leather. No mention was made of the condition of the belt, and, in short, there was very little on which to base a calculation. Others were received of which the above are fair samples.

The editor did not require the letters to be written by expert penmen, nor was it necessary that all of the words should be spelled correctly; but as he desired to oblige everyone, he was disappointed to find that in so many cases important points were omitted which made it impossible to give satisfactory answers.

We have called attention to this incident in order to remind the many correspondents of the mechanical press that full data is necessary in such cases, for if more is given than is needed, it does no harm, but where some is omitted it spoils the whole thing. Many letters are received which are carefully written and contain full particulars, and such receive prompt and full replies, which are a source of satisfaction to all concerned.

THE AMERICAN
GAS LIGHT JOURNAL

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PROPRIETORS.

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NEW YORK.—AMERICAN NEWS CO., 39 and 41 Chambers Street
Germany.—B. WESTERMANN & Co., of New York.

MONDAY, JUNE 25, 1894.

The Market for Gas Securities.

There was no change of moment during the week in quotations for Consolidated gas, although the tendency in it is undoubtedly to wards lower figures. The net loss in the bid rate for the week was ¼ per cent., and the opening to-day (Friday) is reported at 133 to 134. Other city shares show no special change, unless it be in the instance of Standard common, which is inquired after with some frequency. Holders, however, seem indisposed to accept any bid under 30, and prospective buyers are disinclined to offer more than 28½. The Brooklyn situation is mixed up more than ever, nevertheless quotations are maintained at the previous seemingly high rates. In fact, Peoples has had quite a notable raise, being bid for at 76. As it would require a rather prophetic mind to outline the probable outcome in Brooklyn, we imagine it is better to say nothing about it, although we would rather sell than buy at the current quotations. Chicago gas is strong at 78⅛, and Baltimore is also steady and strong, at 64. Consumers, of Jersey City, is at 58 bid, and is likely to go higher.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,
16 WALL ST., NEW YORK CITY.
JUNE 25.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	133	134
Central	500,000	50	100	—
" Scrip	220,000	—	100	—
Equitable	4,000,000	100	185	188
" Bonds	1,000,000	—	106	108
Metropolitan, Bonds	658,000	—	108	112
Mutual	3,500,000	100	152	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	80	95
" Bonds	150,000	—	—	100
Richmond Co., S. I.	348,650	50	50	—
" Bonds	100,000	—	—	—
Standard Gas Co—				
Common Stock	5,000,000	100	—	31
Preferred	5,000,000	100	76	78
Yonkers		50	112	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	103	107
Citizens	1,200,000	20	50	55
" S. F. Bonds	320,000	1000	—	101
Equity Gas Light Co.	2,000,000	100	—	—
Bonds	1,000,000	—	—	—
Fulton Municipal	3,000,000	100	130	132
" Bonds	300,000		103	—
Peoples	1,000,000	10	76	78
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	98	100
Metropolitan	870,000	100	132	136
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	—	155
" Otfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	138	145
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Bay State Gas Co.—				
Stock	5,000,000	50	15	15½
Income Bonds	2,000,000	1000	60	—
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	78	—
2d " " "	3,000,000	1000	57	58
Buffalo Mutual, N. Y.	750,000	100	120	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
Chicago Gas Company.	25,000,000	100	78¼	78⅜
Chicago Gas Light. & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	81⅛	81½
Consumers Gas Light Co., Jersey City	2,000,000	100	58	62
Bonds	600,000	1000	90	94
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	184½	187
Central, S. F., Cal.			90	100
Capital, Sacramento, Cal			—	55
Consolidated, Balt.	11,000,000	100	—	64
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	101
Bonds	250,000		—	—
Detroit Gas Co.—				
Con. Bonds	.....	.....	60	—
East River Gas Co., Long Island City	1,000,000	100	—	—
Bonds	500,000	100	89¼	—
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	101
Hartford, Conn.	750,000	25	120	128
Jersey City	750,000	20	190	200
Louisville, Ky.	2,570,000	50	125	130
Laclede Gas Light Co. St. Louis, Mo.—				
Common Stock	7,500,000	100	16¾	17¼
Preferred "	2,500,000	100	67	69½
Bonds	9,034,400	1000	86	86¾
Little Falls N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	200	208
New Haven, Conn.		25	200	—
Oakland, Cal.			42⅜	43
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Peoples, Jersey City			160	170
" " Bonds			—	—
Paterson, N. J.		25	99	102
Rochester, N. Y.		50	80	85
Preferred			90	95
Bonds			90	95
Syracuse, N. Y.	500,000	25	—	—
San Francisco Gas Co. San Francisco, Cal.	10,000,000	100	71	71½
Washington, D. C.	2,000,000	20	240	—
Wilmington, Del.	500,000	50	180	182

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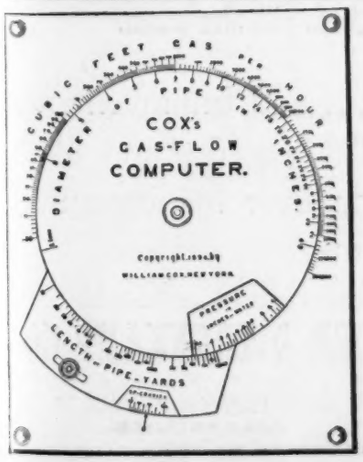

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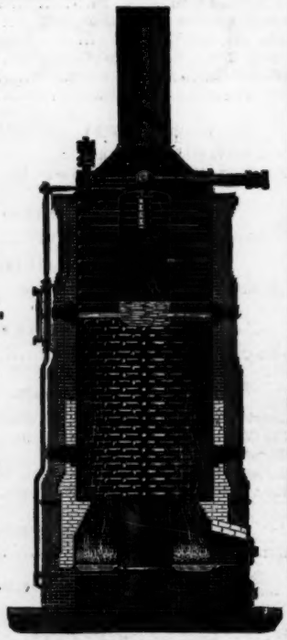

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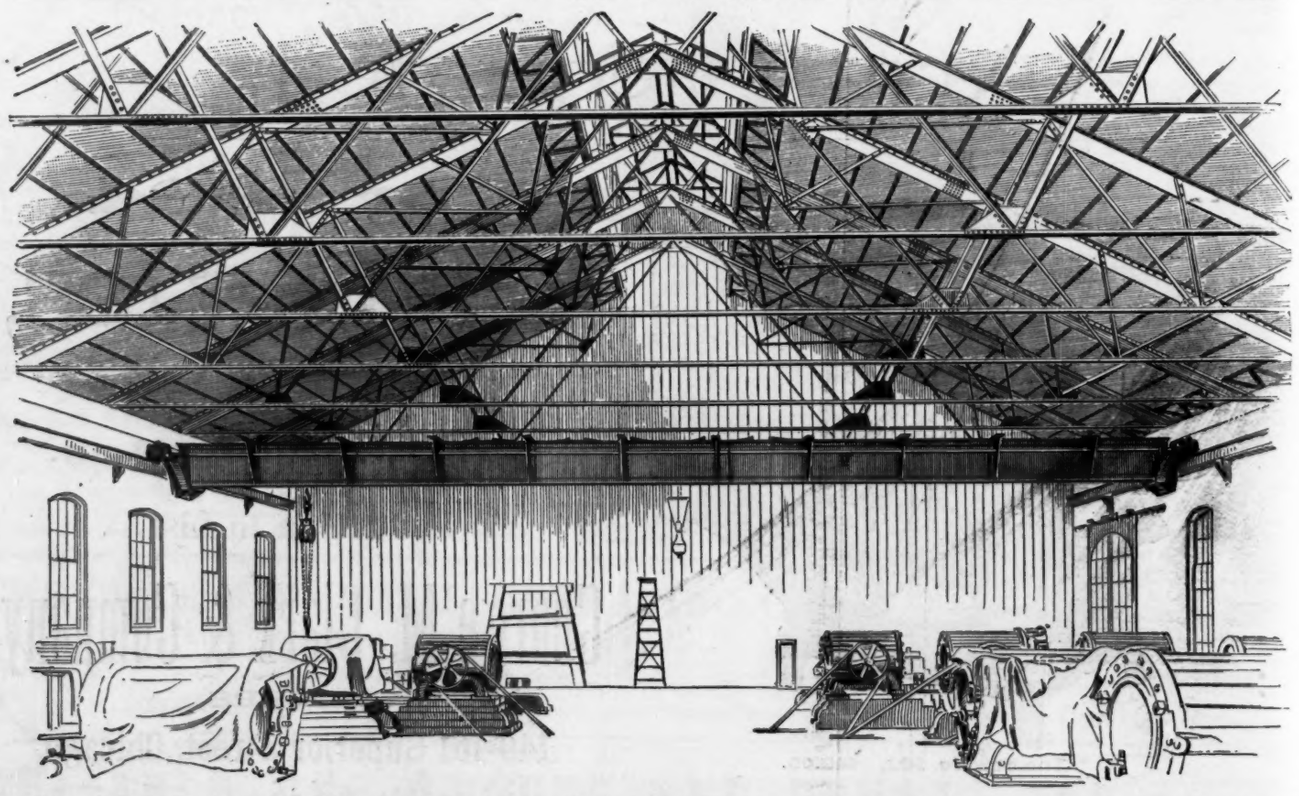

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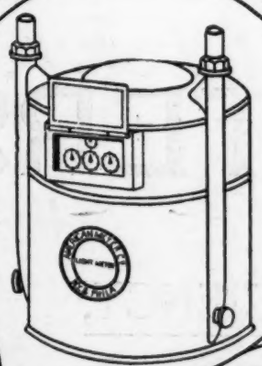

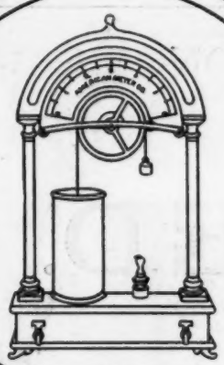

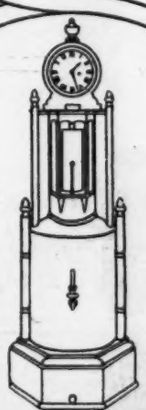

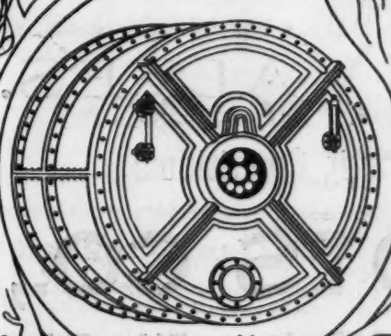

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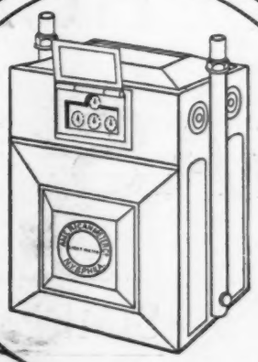

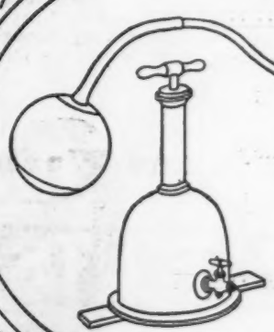

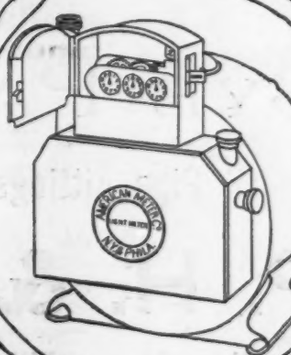

PUBLIC LIGHTING TABLE.

JULY, 1894.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Sun.	1	8.00 PM	3.40 AM	7.30	3.15
Mon.	2	8.00	3.40	7.30	3.15
Tue.	3	8.00 NM	3.40	7.30	3.15
Wed.	4	8.00	3.40	7.30	3.15
Thu.	5	8.00	3.40	7.30	3.15
Fri.	6	8.00	3.40	7.30	3.15
Sat.	7	8.00	3.40	7.30	3.15
Sun.	8	10.10	3.40	7.30	3.15
Mon.	9	10.30 FQ	3.40	7.30	3.15
Tue.	10	10.50	3.40	7.30	3.15
Wed.	11	11.20	3.40	7.30	3.15
Thu.	12	11.50	3.40	7.30	3.15
Fri.	13	12.30 AM	3.40	7.30	3.15
Sat.	14	1.10	3.40	7.30	3.15
Sun.	15	2.00	3.40	7.30	3.15
Mon.	16	No L.	No L.	7.20	3.15
Tue.	17	No L. FM	No L.	7.20	3.15
Wed.	18	No L.	No L.	7.20	3.15
Thu.	19	8.00 PM	9.50 PM	7.20	3.15
Fri.	20	7.50	10.10	7.20	3.15
Sat.	21	7.50	10.30	7.20	3.15
Sun.	22	7.50	10.50	7.20	3.15
Mon.	23	7.50	11.10	7.20	3.15
Tue.	24	7.50	11.40	7.20	3.15
Wed.	25	7.50 LQ	12.00	7.20	3.15
Thu.	26	7.50	12.30 AM	7.20	3.15
Fri.	27	7.50	1.10	7.20	3.15
Sat.	28	7.50	2.00	7.20	3.15
Sun.	29	7.50	4.00	7.20	3.15
Mon.	30	7.50	4.00	7.10	3.30
Tue.	31	7.50	4.00	7.10	3.30

TOTAL HOURS LIGHTING DURING 1894.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	244.10	January	423.20
February	195.30	February	355.25
March	206.20	March	355.35
April	169.40	April	298.50
May	162.10	May	264.50
June	135.40	June	234.25
July	146.30	July	243.45
August	162.20	August	280.25
September	174.10	September	321.15
October	211.20	October	374.30
November	221.00	November	401.40
December	245.30	December	433.45
Total	2274.20	Total	3987.45

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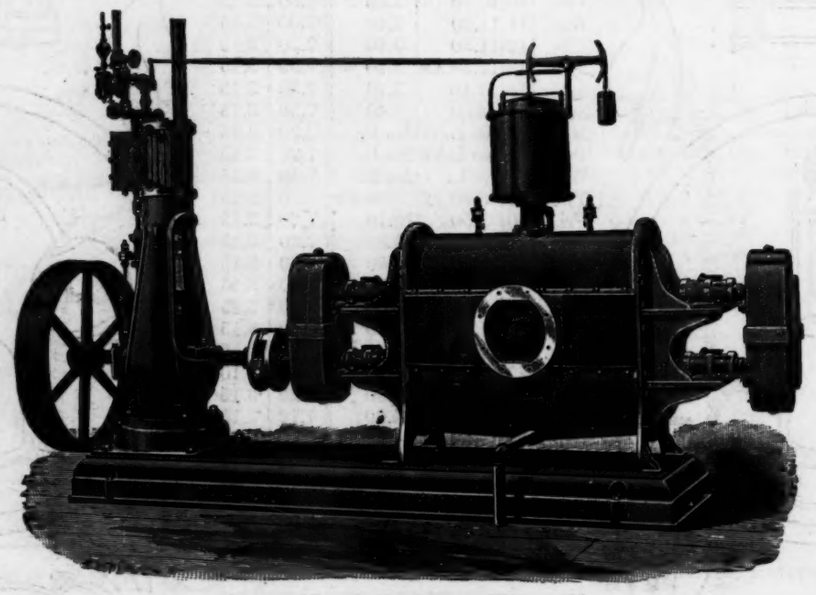

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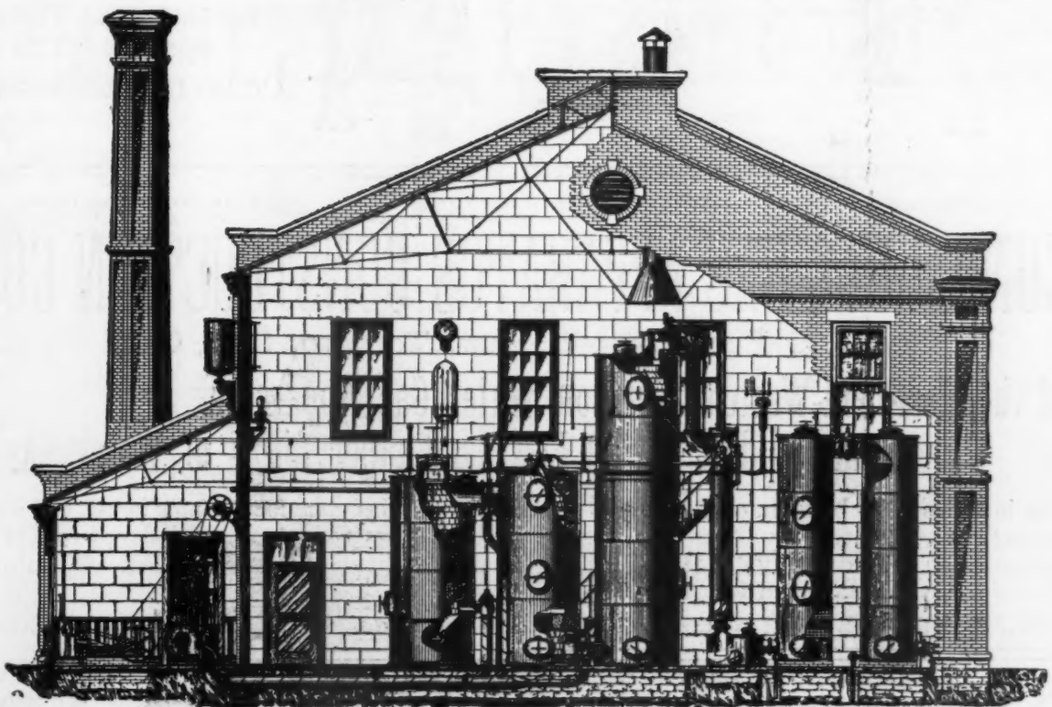

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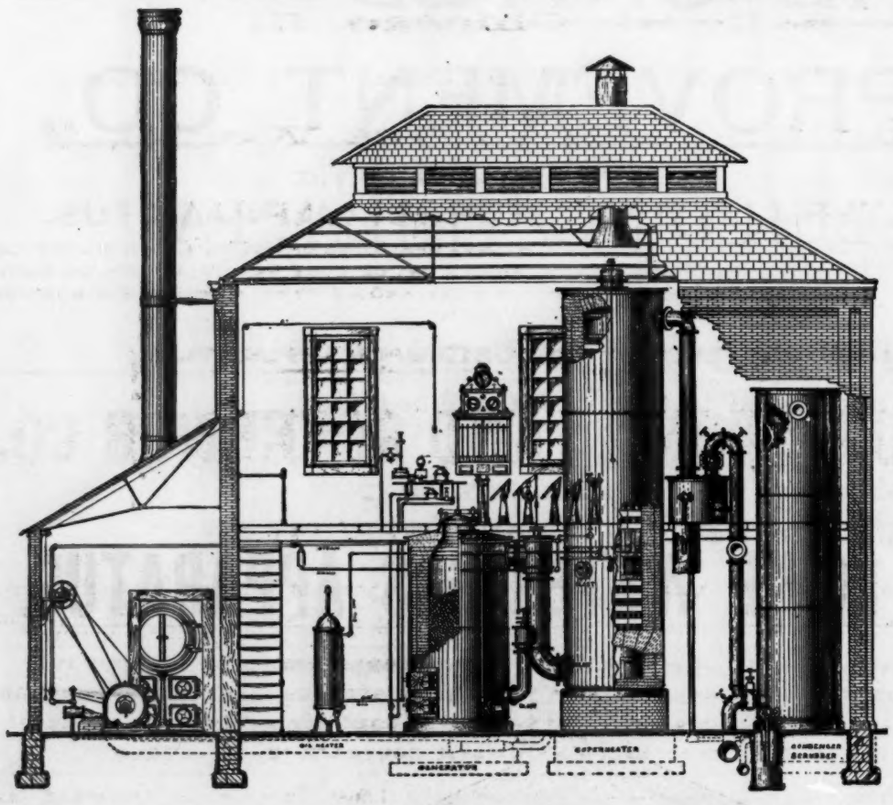

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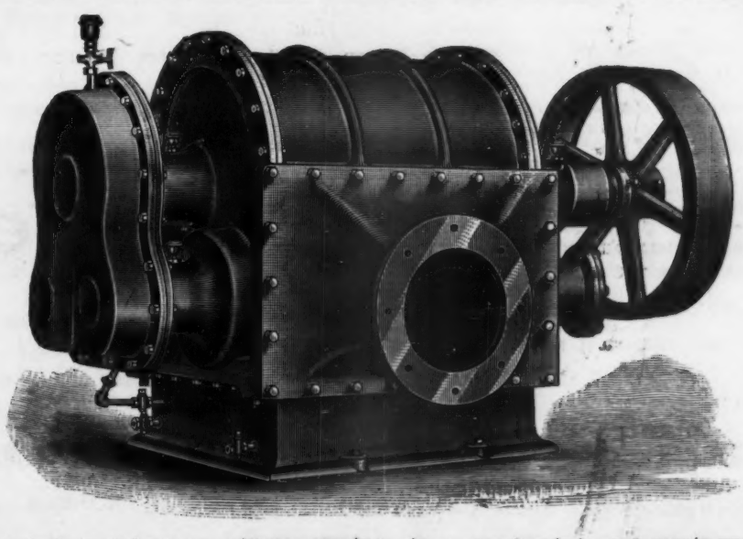

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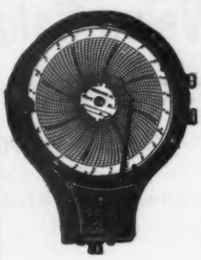

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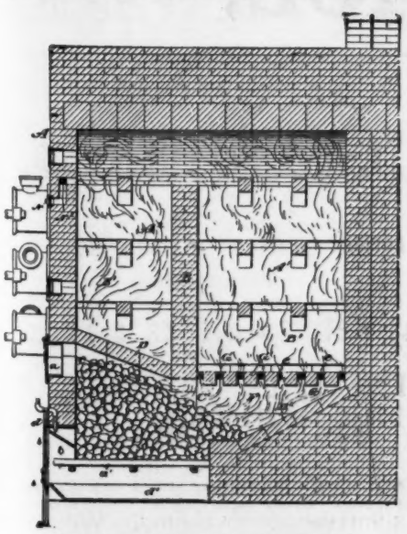

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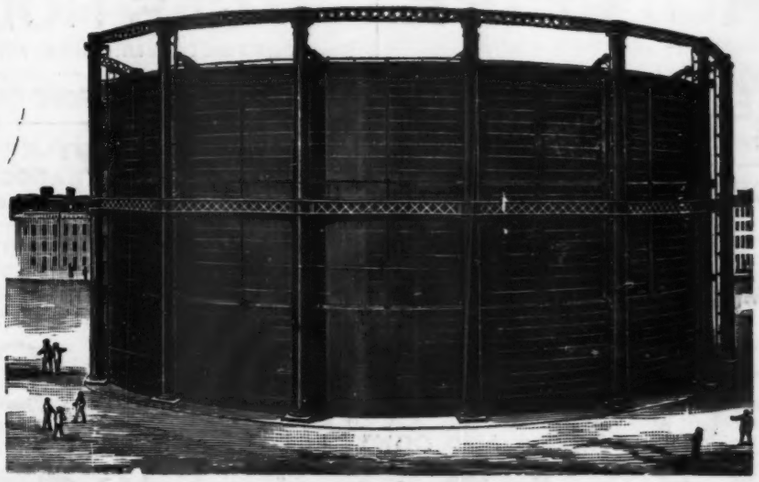

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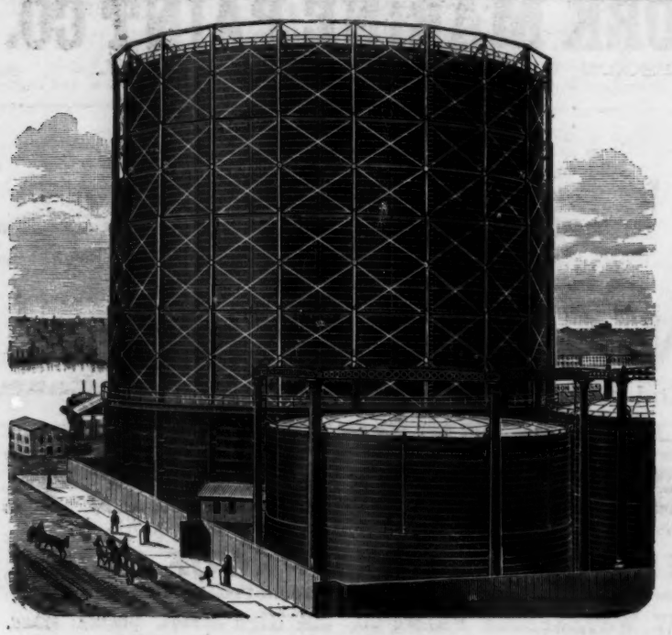

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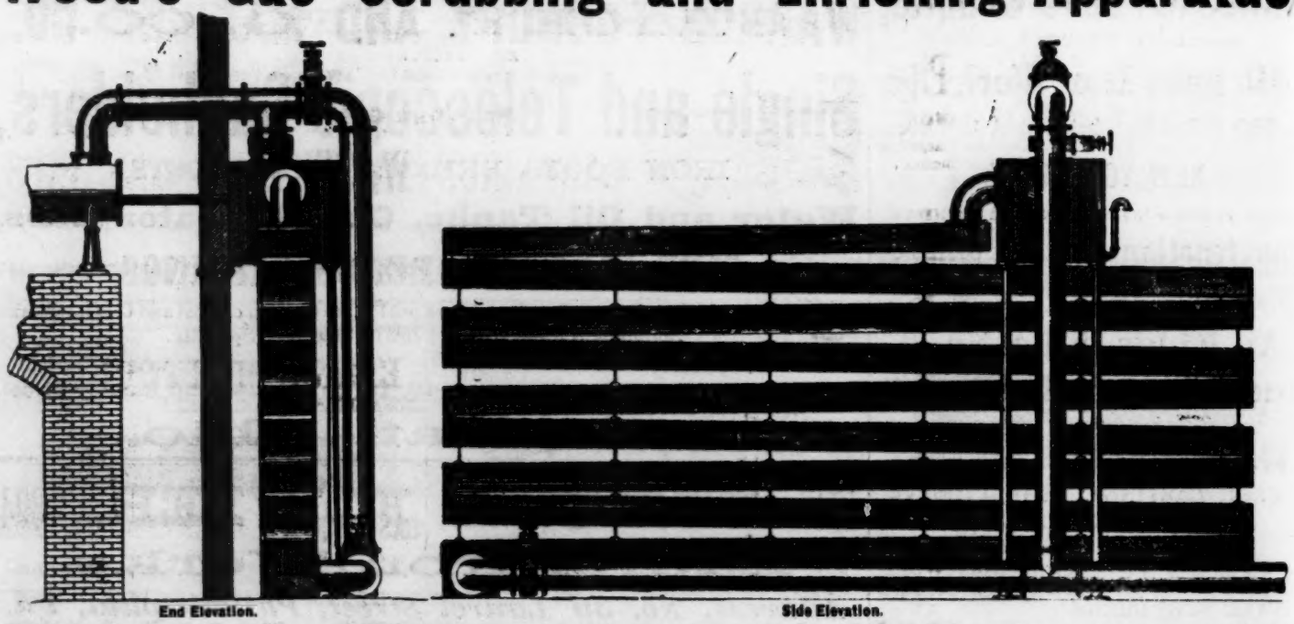

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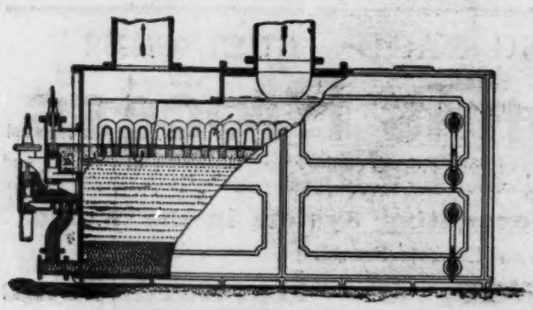

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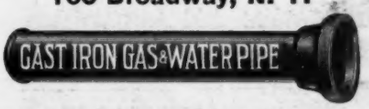

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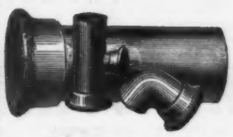

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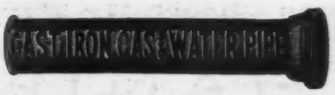

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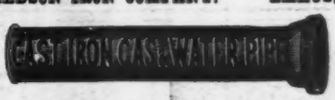

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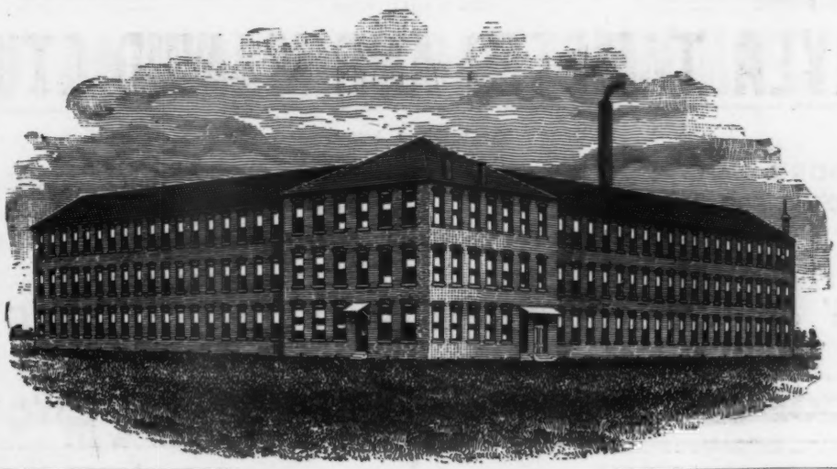

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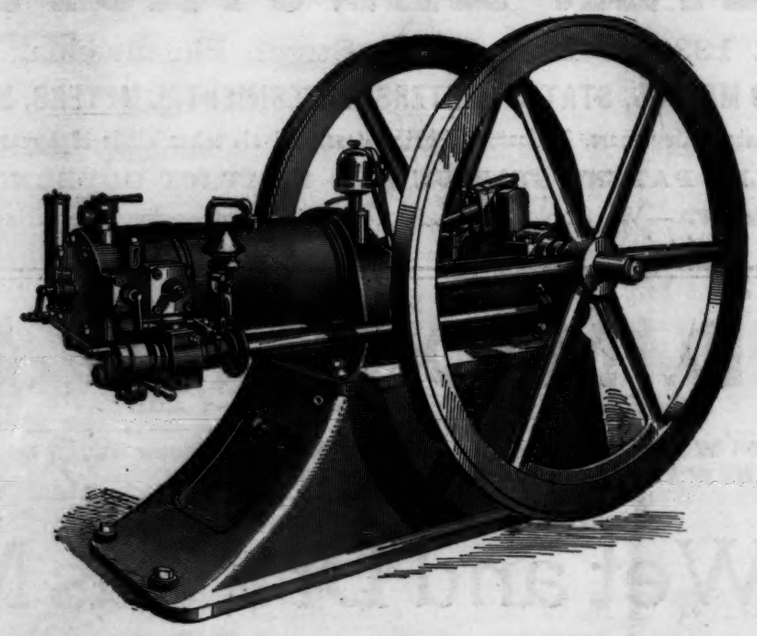

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